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Synchronous and Asynchronous Collaboration Technology Use in Teamwork

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SYNCHRONOUS AND ASYNCHRONOUS COLLABORATION TECHNOLOGY USE IN TEAMWORK

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ABSTRACT

With the increasing geographic dispersion of project teams and the evolution of collaboration technologies, organizations are increasingly facilitating synchronous and asynchronous collaboration amongst dispersed team members using information technologies. While the facilitating role of collaboration technologies to enhance the outcomes of project teams has been examined in prior research, little, as of yet, is known about the influence of a project team member's task characteristics and extent of usage of collaboration technologies on that member's project task outcomes.

This study drew upon media richness theory to examine the impacts of a project team member's task characteristics and extent of usage of collaboration technologies on that member's task outcomes. It hypothesized that characteristics of a team member's project-related task such as uncertainty, equivocality, interdependence, and differentiation influenced the member's perceptions of task outcomes such as knowledge sharing, satisfaction, and productivity. These outcome perceptions were moderated by usage of collaboration technologies and this moderation effect was stronger for synchronous technologies as compared to asynchronous technologies. To test the hypotheses, a survey questionnaire was used to collect data from project team members of multiple organizations.

The analysis of the data revealed that task uncertainty, equivocality, interdependence, and differentiation significantly influenced task knowledge sharing, satisfaction, and productivity and these task outcomes were positively moderated by usage of collaboration technologies. However, contrary to expectation, this moderation effect was stronger for asynchronous

technologies as compared to synchronous technologies. Task knowledge sharing, satisfaction, and productivity were improved when using asynchronous technologies with equivocal tasks. Task productivity was improved when using asynchronous technologies with interdependent tasks. On the other hand, synchronous technologies did not significantly improve task knowledge sharing, satisfaction, or productivity. These results partially support media richness theory and indicate that project team members do not always choose the mode of communication based on matching task characteristics and outcomes to the medium.

This dissertation contributes to extant literature by extending media richness theory to the context of usage of collaboration technologies by project teams and discusses several implications for research and practice.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION **1**

1.1 Statement of the Problem 1

1.2 Background 2

1.3 Research Questions 4

1.4 Primary Contributions 4

CHAPTER 2: LITERATURE REVIEW **6**

2.1 Media Richness Theory 6

2.2 Synchronous Collaboration Technologies 14

2.3 Asynchronous Collaboration Technologies 16

2.4 Task Outcomes 17

CHAPTER 3: RESEARCH MODEL AND HYPOTHESES **20**

3.1 Research Model 20

3.2 Hypotheses 21

CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY **46**

4.1 Research Design 46

4.2 Measures 46

4.3 Data Collection 53

4.4 Pretest and Pilot Test 54

4.5 Sample 55

4.6 Model Measurement 59

4.7 Hypothesis Testing 69

CHAPTER 5: DISCUSSION **77**

5.1 Discussion on Hypothesis Testing Results 77

5.2 Implications for Researchers 85

5.3 Implications for Practitioners 87

5.4 Limitations and Future Research 88

CHAPTER 6: CONCLUSION **91**

REFERENCES **93**

APPENDIX A: CONSENT FORM **102**

APPENDIX B: SURVEY QUESTIONNAIRE **104**

APPENDIX C: DESCRIPTIVE STATISTICS **113**

APPENDIX D: MODEL FIT SUMMARY **115**

APPENDIX E: MODERATING EFFECTS **122**

CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem

The usage of information technologies by individuals and teams and the outcomes from such usage have for long been of interest to information systems (IS) researchers. A large number of studies have attempted to identify determinants of IS usage such as task characteristics, technology characteristics, individual and group attitudes, or situational characteristics (Davis et al., 1989; Compeau & Higgins, 1995; Goodhue & Thompson, 1995; Taylor & Todd, 1995; Venkatesh et al., 2003; Brown et al., 2010). Likewise, many studies have focused on outcomes for individuals and organizations from IS usage such as knowledge sharing, satisfaction, and productivity (DeLone & McLean, 1992; Sabherwal et al., 2006). However, little empirical research to date has simultaneously examined individual task characteristics and task outcomes in the context of usage of contemporary collaboration information technologies.

Task characteristics and outcomes are critical considerations in the adoption of collaboration technologies by project teams. A recent study by Brown et al. (2010) integrated theories from collaboration as well as technology adoption research to explain the adoption and use of collaboration technologies. The results of that study showed that technology characteristics, individual and group characteristics, task types, and situational conditions influence behavioral intention and use of collaboration technologies. Brown et al. (2010) called for further investigation of the influence of task characteristics on technology use. They

recommended incorporating task aspects such as uncertainty or interdependence within research models in order to uncover the relationship between the role of tasks and the use of collaboration technologies.

Brown et al. (2010) further suggested that synchronicity of communication was a significant characteristic that needed to be carefully examined by future research on collaboration technologies. As project teams have become more geographically dispersed, organizations have increasingly adopted synchronous (i.e., same-time) collaboration technologies such as web conferencing and instant messaging to facilitate collaboration among team members (Dennis et al. 2010). However, usage of asynchronous (i.e., different-time) collaboration technologies such as electronic mail, wikis and blogs continue to play an important role in the exchange of information within project teams. Surprisingly, despite the widespread usage of collaboration technologies in teamwork, little is known about the influence of an individual team member's task characteristics on that member's task outcomes in the context of differential usage of synchronous versus asynchronous collaboration technologies. The results of this study are intended to bridge this gap between real world practice and research literature on collaboration technologies not only as called for by scholars (Martins et al., 2004; Kirkman & Mathieu, 2005) but also to help organizations ensure that the collaboration technologies deployed within their organizations are appropriate to their team members' tasks and benefit the organization.

1.2 Background

Both synchronous and asynchronous collaboration technologies are widely used by

organizations to enhance their employees' communication and collaboration. Synchronous collaboration technologies (e.g. video/web/audio conferencing, instant messaging, and certain group decision support systems) allow all participants from the same or different locations, time zones, or organizations to collaborate on the same tasks in real time, while asynchronous collaboration technologies (e.g. electronic mail, fax, online forums, wikis, blogs, and social networks) are utilized when participants wish to share information but simultaneous interaction is not necessary. It is important to consider that team members often use an array of collaboration technologies to interact with their cohorts. Therefore this study focuses on all kinds of synchronous and asynchronous collaboration technologies available at the disposal of project teams.

Prior work has demonstrated that the fit between tasks and technologies leads to better performance (Goodhue & Thompson, 1995). Due to the real time collaboration capability of synchronous technologies, their use may be beneficial for tasks that by nature are *uncertain*, *equivocal*, *interdependent*, and *differentiated*, especially in situations where the possibility of a face-to-face meeting is limited. *Task uncertainty* is defined as the degree to which work to be performed cannot be anticipated or forecast. *Task equivocality* refers to the degree to which work to be performed is vague or confusing. *Task interdependence* refers to the degree to which work to be performed depends on other individuals to accomplish it. Lastly, *task differentiation* is the degree to which work to be performed is divided into smaller segments on some reasonable basis (Daft & Lengel, 1986).

Moreover, the collaboration technologies that a team adopts and uses (whether synchronous or asynchronous) may differentially impact task outcomes of individual

members in terms of metrics such as *knowledge sharing*, *satisfaction*, and *productivity*. According to Golden and Raghuram (2010), *task knowledge sharing* is defined as a condition to promote the giving and receiving of know-how and other insights, and a willingness to exchange wisdom and acquired experiences about a task through direct or indirect interactions. *Task satisfaction* refers to the fulfillment or gratification of a desire, need, or appetite for a task. Finally, *task productivity* in this study measures the perception of a project team member on how well the resources are being used to produce an end-product through a task. This study extensively draws upon media richness theory to understand the impacts of a team member's task characteristics and synchronous versus asynchronous collaboration technology usage on the task outcomes.

1.3 Research Questions

This study seeks to answer the following two questions:

1) Which characteristics of a project team member's task influence the team member's task outcomes?

2) What is the differential impact of usage of synchronous versus asynchronous collaboration technologies on the relationship between the team member's task characteristics and task outcomes?

1.4 Primary Contributions

By exploring the interactions of task with technology to discover how different technology capabilities match different task characteristics, this study helps organizations

better support their project teams and improve task outcomes using collaboration technologies. Practitioners utilize this study to understand the role played by task characteristics and collaboration technology usage as well as the benefits accruing to team members from such usage. This understanding leads to improved adoption and utilization of collaboration technologies in organizations. The project team members do not only know how, but also why or when to use the tools at their disposal.

Moreover, this study extends prior research that has focused primarily on traditional collaboration technologies (e.g. electronic mail, fax, newsgroups, discussion boards, and early group decision support systems) as discussed in Adams et al. (1992), Chidambaram & Jones (1993), Turoff et al. (1993), Alavi (1994), Lee (1994), Straub (1994), Ngwenyama & Lee (1997), Kahai & Cooper (2003), and Massey et al. (2003). The current study adds a new dimension to prior research comparing virtual with traditional face-to-face teams by examining the influence of synchronicity of collaboration tools (Martins et al., 2004; Kirkman & Mathieu, 2005). In addition, the current study extends media richness theory to the usage of IS in a project team. The study also includes multiple constructs of task outcomes rather than a single construct as is common in prior literature (Goodhue & Thompson, 1995; Koo et al., 2011; Jean et al., 2014). Finally, this study shifts away from commonly utilized laboratory settings in prior research that has typically examined student teams working on short-term tasks (Chidambaram & Jones, 1993; Alavi, 1994; Dennis & Kinney, 1998; Kahai & Cooper, 2003; Massey et al., 2003), to a field setting with more generalizable results.

CHAPTER 2

LITERATURE REVIEW

2.1 Media Richness Theory

Media richness theory seeks to answer the question as to why organizations process information. This theory originates from several assumptions. The most basic assumption is that organizations must process information to accomplish tasks, but they have limited capacity. Due to the organizational division of labor, in order to process information in organizations, each department or subgroup must perform its tasks. The tasks must be coordinated with one another. However, employees who receive or send data within organizations may have different interpretations of the same event. Therefore organizational information processing needs to account for the diversity of each individual. Furthermore, uncertainty and equivocality may occur during coordination amongst parties. The uncertainty and equivocality perspectives on information processing were integrated into the theory by Daft and Lengel (1986) to understand and predict the appropriate organizational structure for a specific situation.

Therefore there are four related aspects in media richness theory proposed by Daft and Lengel (1986). These four aspects are *uncertainty*, *equivocality*, *interdependence*, and *differentiation*. Daft and Lengel (1986) adopted the assumptions related to task uncertainty from the information processing theory of Galbraith (1974). The purpose of Galbraith's information processing theory was to explain why task uncertainty is related to organizational forms. A basic proposition of the theory is that the greater the task uncertainty, the greater is

the amount of information that must be processed among decision makers during the execution of the task in order to achieve a given level of performance. If the task is well understood prior to performing it, many activities can be preplanned. Otherwise, during the actual task execution, more knowledge is acquired, resulting in changes in resource allocations, schedules, and priorities.

The basic effect of task uncertainty is to limit the ability of employees to preplan or to make decisions about activities in advance of their execution. As a result, it is more difficult for experts to exercise their knowledge and power, leading to poorer decision making. Therefore, the theory suggests that the observed variations in organizational forms are variations in the strategies of decision makers to (1) increase their ability to preplan, (2) increase their flexibility to adapt to their inability to preplan, or (3) decrease the level of performance required for continued viability. These strategies, which include the creation of slack resources, creation of self-contained tasks, investment in vertical information systems, and creation of lateral relations, are employed to reduce the need for information processing and to increase the capacity to process information.

In their media richness theory, Daft and Lengel (1986) proposed that the decision makers within the organization process information to reduce uncertainty and equivocality. In other words, uncertainty and equivocality force information processing in organizations or project teams. Uncertainty as defined by Galbraith (1974) is the difference between the amount of information required to perform the task and the amount of information already possessed. Consequently, employees that face high uncertainty must acquire new data to perform tasks. Equivocality is defined as an ambiguity or existence of multiple and conflicting

interpretations about a situation (Weick, 1979; Daft & Macintosh, 1981). Employees with high task equivocality thus need to exchange opinions amongst themselves to perform tasks.

Daft and Lengel (1986) also postulated that the work structure can be designed to provide sufficient information to reduce uncertainty and rich information to reduce equivocality. Work structure is the allocation of tasks to individuals and groups within an organization and the design of systems to ensure effective communication (Child, 1977). Work structure can be facilitated through the use of various mechanisms to reduce uncertainty and equivocality. These mechanisms range from rich to lean communication mediums including group meetings, integrators, direct contact, planning, special reports, formal information systems, and rules and regulations.

Daft and Lengel (1986) adopted the assumptions of task interdependence from Thompson (1967). Task interdependence can be defined as the extent to which departments or employees depend upon each other to accomplish their tasks. Thompson (1967) examined how task interdependence affects work structure and technology. He defined three models of task interdependence: pooled interdependence, sequential interdependence, and reciprocal interdependence.

In pooled interdependence, each employee or department may not directly support others. Yet task failures of any one can threaten the others or the whole organization. This situation can be described as one in which each employee or department renders a task contribution to a whole and each is supported by the whole.

In sequential interdependence, task interdependence takes a serial form. An output of an employee or department is an input of another. Here both make contributions to and are

sustained by the whole organization. So, there is a pooled aspect of task interdependence. In addition, the order of the interdependence can be specified. One must act properly before another can act.

Lastly, reciprocal interdependence refers to the situation in which the outputs of each employee or department become inputs for the others and vice versa. Each unit involved is dependent on the other. There is a pooled aspect to this interdependence, and there is also a serial aspect. The different aspect herein is the reciprocity of the interdependence, with each unit being contingent on the other for information.

With the distinguishing degrees of task interdependence, Thompson (1967) asserted that different devices for achieving coordination would be expected. Under the situation that involves the establishment of routines or rules which constrain action of each employee or department to be the same as others in the interdependence relationship, coordination may be achieved by standardization. An important assumption in coordination by standardization is that a set of rules are applied in the relatively stable or repetitive situations. Standardization requires few frequent decisions and a small volume of communication during a specific period of operations.

Under another situation that involves the establishment of schedules for the interdependent employees or departments, coordination by plan would be used. It does not require the same high degree of stability and routinization as coordination by standardization. Therefore, it is more appropriate in dynamic situations, especially when task environment is changing.

The last form is coordination by mutual adjustment. It involves the transmission of new

information during the process of action. The more variable or unpredictable the situation, the greater should be the reliance on coordination by mutual adjustment. However, this type of coordination places a heavy burden on communication and decision making.

In media richness theory, Daft and Lengel (1986) defined interdependence as a source of uncertainty and equivocality. Based on the assumptions of different collaboration devices for different degrees of interdependence proposed by Thompson (1967), Daft and Lengel (1986) asserted that rich media enables employees to resolve disagreement and misunderstanding that can arise among departments, subgroups, or employees. Rich communication media are preferred in a situation that requires immediate feedback, a large number of cues, personalization, and language variety. Lean media, on the other hand, are appropriate when the information needed for coordination is minimal or routine.

Lastly, Daft and Lengel (1986) adopted the assumptions related to task differentiation from Galbraith (1974) who defined another framework in the organizational information processing theory which assumes that an organization is large and employs a number of specialist groups and resources in providing an output. After a task has been divided into subtasks, the problem is to integrate the subtasks into a global task. This is an organizational design problem. The behaviors that occur in one subtask are effective or ineffective depending upon the behaviors of the other subtask performers. There will be a design problem if the executors of the behaviors cannot communicate with all the roles with whom they are interdependent.

Daft and Lengel (1986) incorporated task differentiation in media richness theory. They stated that normally an organizational activity is subdivided into a group of tasks that is

broken down and assigned to many positions within the organization. Because each employee or department develops his or its own specialization, experience, values, priorities, time horizon, goals, and jargon (Lawrence & Lorsch, 1967; Shrivastava & Mitroff, 1984), a task is usually assigned to an employee or department based on such factors. This phenomenon can be called task differentiation.

The media richness theory of Daft and Lengel (1986) has provided the theoretical basis for many IS studies. For instance, Dennis and Kinney (1998) used the theory in the context of newer media (i.e., video and computer-mediated communication) to study the effects of media richness on individual decision-making in two-person student teams. Their laboratory experiment utilized two tasks that varied in equivocality and four communication media, i.e., audio-video with immediate feedback, audio-video with delayed feedback, simultaneous text chat, and delayed text chat. They concluded that contrary to the theory, performance did not improve when teams matched rich media (i.e., media that provided greater multiplicity of cues and more immediate feedback) to equivocal tasks. Dennis and Kinney's (1998) contrary findings were echoed by Kraut et al., (1998) who discovered that use of video telephony by managers with people management jobs was not significantly more than its use by other managers, as the theory had led them to hypothesize. Therefore researchers have claimed that there are many findings that media richness theory cannot explain, especially with newer media like video conferencing, though the theory performs reasonably well in the context of traditional communication media such as face-to-face, phone, and written memos (Rice, 1992; Kahai & Cooper, 2003).

On the other hand, several studies have found strong support for the premises of media richness theory. For instance, Kahai and Cooper (2003) studied 3- to 4-member student groups for two equivocal negotiation tasks (i.e., developing plans to cope with substance abuse and student housing) in a laboratory experiment. The communication systems that they utilized were partially technology based, i.e., face-to-face meeting in which each participant recorded key points on paper, face-to-face meeting in which groups worked on a shared document editor, electronic conferencing via a shared file viewable to all participants on their monitors, and e-mail. They examined the impacts of multiplicity of cues (i.e., the number of ways in which information can be communicated such as text, verbal cues, and non-verbal cues), and immediacy of feedback provided by the collaboration systems on three mediating variables, i.e., social perceptions, message clarity, and the ability to evaluate others. Their overall dependent variable was group decision quality, which they found was positively impacted by richer media when participants had high task-relevant knowledge.

Similarly, Johnson and Lederer (2005) extended the theory to predict that communication channel richness leads to mutual understanding between an organization's Chief Executive Officer (CEO) and Chief Information Officer (CIO). Their study explored five communication channels used by the officers, i.e., face-to-face, e-mail, business memo, voice mail, and telephone. Likewise, based on media richness theory, Banker et al. (2006) concluded that use of rich collaboration software that enabled both synchronous and asynchronous information exchange increased the extent of collaboration among product design teams and improved product design quality, design turnaround time, and design reuse. It also lowered documentation and rework costs.

Unfortunately, there has been scarcity of empirical evidence to examine the other two important constructs of interdependence and differentiation based on the media richness theory of Daft and Lengel (1986). Still, the prior research on task interdependence and differentiation provide worthy references to demonstrate the relationships among these characteristics, task outcomes, and information technology. Billings et al. (1997) longitudinally examined the effects on job characteristics due to the implementation of a new IS in an organization. Task interdependence was one of the job characteristics in their analysis and it was found to gradually increase after implementation of the new technology. Sharma & Yetton (2007) investigated the main effect of training on information systems implementation success. Task interdependence was identified as a contingency influencing the effect of training on successful IS implementation. Their findings supported a contingent model in which training was a necessary component of a successful implementation strategy when task interdependence was high. Sander and Courtney (1985) examined the influence of the user's task interdependence on Decision Support System (DSS) success and found a positive influence between the level of interdependence and DSS success for managers in the context of decision making. Lloria (2007) explored the role of differentiation in the creation of knowledge within the organization. Her study showed that the lower the vertical differentiation of work as enabled by information technologies through storage and transfer of explicit knowledge, the more was the autonomy enjoyed by the individual, which lead to the creation of new knowledge.

Given the mixed empirical results attributed to the theory and the predilection of prior studies to explore only the constructs of *uncertainty* and *equivocality* through the lens of the

theory but not the constructs of *interdependence* and *differentiation* as identified by Daft and Lengel (1986), this dissertation proposes to test the theory in the context of extent collaboration technologies using a field survey of individuals working in project teams on tasks varying in uncertainty, equivocality, interdependence, and differentiation.

2.2 Synchronous Collaboration Technologies

In general, a synchronous collaboration technology is defined as a tool that enables instantaneous collaboration across organizational, temporal, and physical boundaries amongst individuals who engage in a common task. Some studies though have also examined co-located individuals who perform a common task and employ synchronous collaboration technologies (Kirkman & Mathieu, 2005; Gibson & Gibbs, 2006). A wide range of different synchronous collaboration technologies are used in organizations including but not limited to telephone, video/web/audio conferencing, and instant messaging. Contemporary synchronous collaboration technologies such as web conferencing and instant messaging will be discussed in this section.

Web conferencing software offers a variety of functions such as web collaboration, virtual training, and online learning. However, this study only focuses on web collaboration services in the corporate arena. Currently, the leading web conferencing software products include Adobe Connect, CiscoWebEx Meeting Center, and Citrix GoToMeeting (Karcher et al., 2013). Such software offer different features and scalability options that best suit a wide range of meeting types, sizes, and business situations with multiple subscription rate fees. However, one feature they all share in common is the ability to closely replicate the

traditional face-to-face meeting by enhancing discussions, making the meetings easy and efficient for participants to work together, and enabling faster and effective decision-making. Users can schedule meetings; setup registration; invite participants; present slides; share information, documents and ideas; share their desktop or applications; share control; record, playback, or publish meetings; publicly or privately chat; conduct polling; and conduct post-meeting surveys or post-event e-mails. Participants can join the meeting from multiple platforms such as Windows, Mac, Linux, UNIX, or Solaris, or from a mobile device.

Instant messaging is a communication technology that allows real time text-based conversation between two or more participants over the Internet. Popular social networking providers and even web conferencing tools also offer instant messaging features. According to a recent study, twenty six percent of instant messaging users use it in the workplace (Lowry et al., 2011). In large organizations, more sophisticated instant messaging applications may be adopted as an instant business communication medium among employees. The leading instant messaging applications used in organizations include but are not limited to IBM Lotus Sametime, and Microsoft Lync, among others (Gann, 2012). The common features of enterprise instant messaging tools are the abilities to search the corporate directory, chat with online users or send offline message to contacts, view messages received while offline, archive chat history, transfer files, and multi-participant voice and video calling. Participants can use instant messaging from both desktop systems as well as mobile devices. Research shows that instant messaging usage can change the processes of teamwork collaboration in such a way that employees are able to influence collaborative decision-making through behind-the-scene conversations termed invisible whispering (Dennis et al., 2010). This type

of interactive conversation would be physically impossible without such technology. However, the primary benefit of instant messaging in the workplace is the ability to immediately communicate with other employees to solve business problems (Lowry et al., 2011).

2.3 Asynchronous Collaboration Technologies

An asynchronous collaboration technology refers to a tool that allows exchange of information in which different individuals might receive the information at different times. Examples of early asynchronous collaboration technology used in organizations include but are not limited to electronic mail, fax, newsgroups, and discussion boards. At present, there are many other technologies that help further support collaboration within a team, department, organization, or multiple organizations, for example, the emergent technologies in Web 2.0 such as wikis, blogs, and social networks. Web 2.0 tools allow interactive information sharing or collaboration amongst users (Boulos et al., 2006), and therefore have seen a rapid increase in their usage by organizations in recent years, changing how employees interact with each other as well as with customers or suppliers (Bughin & Chui, 2010).

A wiki is an online collaboration tool with features that allow users to create a topic to share information and to track authors of the information. In organizations, a wiki can serve as an online repository for sharing knowledge, including its evolution to the current state, among employees or participants in a group project or department. In the current study, the team's members can collaborate through the wiki to share or retrieve data on their team's tasks.

A blog or weblog refers to a website that allows users to share their information or opinions in a form of online journal, while readers can make comments which are kept in a reversed chronological order. This characteristic makes blogs differ from wikis in that only the blog owner is permitted to post entries, whereas readers are restricted to only comment on the posted entries. In terms of patterns to use, a blog usually links to other blogs in the same category or interest area. Similar to enterprise wikis, blogs can be open space for the team's members to share or retrieve data on their team's tasks.

Social networks are websites that connect users and allow them to share information. In the current study, on the team social network, the team's members can create a team profile, list their team members' contact and information, add other team's members, communicate with team's member through private or public messages, update their status, and create or join common interest groups or events. A social network can be a place for the team's members to stay connected and collaborate on their team's tasks. Twitter is an example of a social network website that enables users to write and read messages to update their current status or news. Users can create, discover, and share ideas with others. They may also subscribe to other authors' messages to follow particular authors. A team's members may adopt Twitter as a communication platform to quickly share information with each other, to gather feedback, and to stay connected with members of other teams.

2.4 Task Outcomes

This dissertation considers multiple metrics of task outcomes rather than a single metric (Goodhue and Thompson, 1995; Koo et al., 2011). These include *task knowledge sharing*,

task satisfaction, and *task productivity*. *Task knowledge sharing* is a condition that promotes the giving and receiving of know-how and other insights, and a willingness to exchange wisdom and acquired experiences about a task through direct or indirect interactions. Knowledge sharing is an interesting and important aspect in teamwork collaboration because it can be of formal, informal, planned, or impromptu nature. Knowledge sharing by individuals is sometimes difficult, especially for the tacit knowledge (Nonaka, 1994). It was brought into the context of telework by Golden & Raghuram (2010). They found the qualities of teleworkers such as trust, interpersonal bonding, and organizational commitment, to impact knowledge sharing. The impact of trust on knowledge sharing was found to be moderated by technology support, face-to-face interactions, and use of electronic tools, such that the more extensive the technology support, face-to-face interactions, and use of electronic tools, the stronger were the positive impacts on knowledge sharing.

Task satisfaction refers to the fulfillment or gratification of a desire, need, or appetite for a task. Satisfaction is often considered a construct representing the success of an IS (Sabherwal et al., 2006). IS success has served an important dependent variable in considerable empirical research. A comprehensive understanding of IS success was provided by Sabherwal et al. (2006). They found from the construct to be influenced by system quality and user satisfaction. They concluded that the relationships between satisfaction and system use, and between satisfaction and perceived usefulness, might depend on other factors such as attitude toward IS. DeLone & McLean (1992) also recommended that studies involving user satisfaction as the dependent variable should consider user attitude. Hence, this study includes constructs related to team members' attitude toward their tasks and their task satisfaction.

Task productivity is the ratio between inputs (labor, materials, effort, etc.) and outputs (goods and services) of a task. Productivity is another important construct employed by many IS researchers to evaluate IS success (Delone & McLean, 1992). It can be viewed from multiple perspectives such as labor and capital (Ferratt & Argarwal, 1994; Menon et al., 2000), efficiency and effectiveness (Elam & Thomas, 1989), or perceived usefulness (Davis, 1989). Task performance is very similar to task productivity and could be considered as a part of task productivity. It emphasizes on the overall execution or accomplishment of a task and is usually measured by the quality of the output (Belanger et al., 2001). The current study considers task productivity because it has been a significant construct in IS but has not been much explored widely in the context of collaboration technology usage in teamwork.

CHAPTER 3

RESEARCH MODEL AND HYPOTHESES

3.1 Research Model

The research model shown in Figure 1 depicts the relationships between task characteristics, synchronous and asynchronous collaboration technology use, and task outcomes. The model focuses on the prediction of task outcomes by task attributes as moderated by collaboration technology usage. The constructs and related hypotheses, as indicated in the research model, are discussed below.

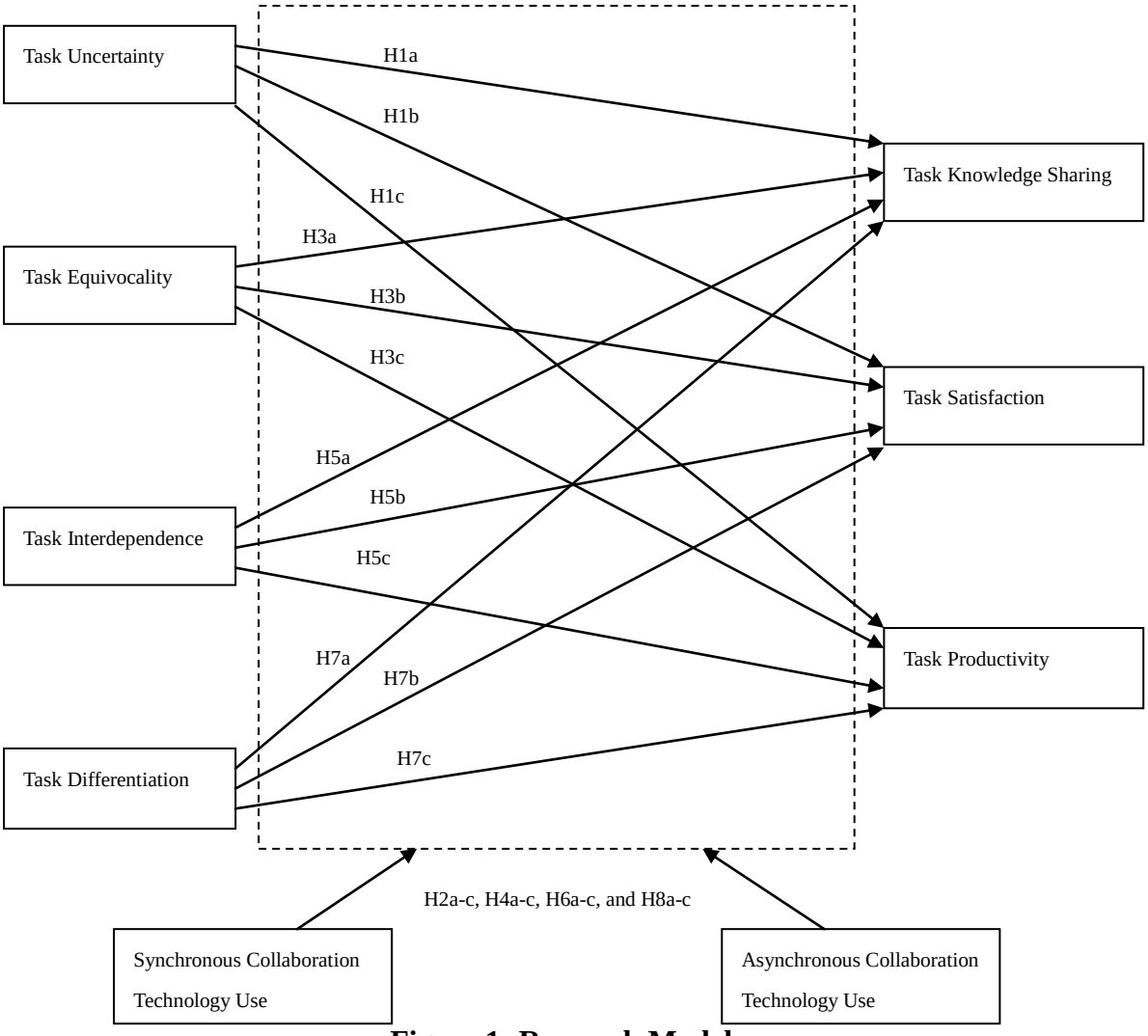


Figure 1: Research Model

3.2 Hypotheses

Tasks are broadly defined as the actions carried out by individuals in turning inputs into outputs. In the Task-Technology Fit Theory of Goodhue and Thompson (1995), the fit between task characteristics and technology characteristics influences performance and utilization of the technology. Task characteristics can move users to rely more heavily on certain aspects of the information technology. This study examines a project team member's major task in a project on which the member's team is collaborating (or had collaborated) using one or more synchronous collaboration tools (e.g. video/web/audio conferencing and instant messaging) and one or more asynchronous collaboration tools (e.g. electronic mail, fax, newsgroups, discussion boards, wiki, blog, social network, and Twitter). The reason to focus on a single team project is that team members today often do not belong to a traditional single permanent team. Instead, they may work in temporary teams or multiple teams simultaneously (Kirkman & Mathieu, 2005; Mathieu et al., 2008; Maynard et al., 2012) and such teams may collaborate differently.

For an information technology to have a positive impact on performance, the technology must be utilized and must fit well with the tasks it supports (Goodhue & Thompson, 1995). This dissertation highlights the importance of there being a fit between the synchronous and asynchronous collaboration technologies used by the team and the team members' task characteristics in order to achieve task success. To better understand the relationships among these constructs, task impacts (dependent variables), collaboration technology use (moderators), and task characteristics (independent variables), are explained in detail below. Hypotheses to predict such relationships are then developed based on assumptions from the

media richness theory of Daft and Lengel (1986).

3.2.1 Dependent Variables

Task Knowledge Sharing

Task knowledge sharing is a condition that promotes the giving and receiving of know-how and other insights, and a willingness to exchange wisdom and acquired experiences about a task through direct or indirect interactions. It measures an awareness of distributed expertise and resources, ease of coordination across geographic distances, and comfort in approaching other distributed team members for help. Task knowledge sharing in this study includes the perception of a project team member on sharing conditions and willingness to exchange knowledge with other members in the project team.

Task Satisfaction

Task satisfaction means the fulfillment or gratification of a desire, need, or appetite for a task. It happens when a team member responds with positive rather than negative feelings to his or her task. Hence, task satisfaction in this study measures the attitude of the project team member towards his or her task.

Task Productivity

Task productivity is viewed as the ratio between inputs (labor, materials, effort, etc.) and outputs (goods and services) of a task. Productivity is a measure of the efficiency of the production or ability to produce a good or service. In other words, productivity is the measure of how resources are managed to accomplish the stated goals in terms of quantity and quality.

Therefore, task productivity in this study measures the perception of a project team member on how well the resources are being used to produce an end-product through a task.

3.2.2 Moderators

Synchronous and Asynchronous Collaboration Technology Use

Synchronous collaboration technology use refers to the extent of usage of information technologies that facilitate real time (i.e., same-time) communication and collaboration between a team's members, whereas asynchronous collaboration technology use refers to the extent of usage of information technologies that enable communication and collaboration over a period of time (i.e., different-time).

3.2.3 Independent Variables

Task Uncertainty

Task uncertainty is defined as the degree to which work to be performed cannot be anticipated or forecast. According to the assumptions in Galbraith's (1974) information processing theory, task uncertainty can cause changes in resource allocations, schedules, and priorities. When a team member deals with fluctuation in information available to perform his or her task, the task is subject to uncertain events, no procedures and practices are established for performing the task, then the member will face difficulties in planning resource allocations, task schedules, and task priorities. Therefore, in this study, when a team member's task becomes more uncertain, the member is expected to have difficulty in planning or making decisions about the task. As a result, the member's knowledge sharing is likely higher. To

discuss problems and to get solutions related to the task from other team members is necessary. Hence, we hypothesize,

Hypothesis 1a*: The greater the uncertainty in a team member's task, the greater will be that member's task knowledge sharing.*

When the team member perceives his or her task to be highly uncertain, the member is likely not satisfied with the task. He or she may find it difficult to get help related to the task from the organization, supervisor, or other team members when needed as well as difficulty in organizing his or her scant resources, tight schedules, and multiple priorities. This finally makes the member feel a sense of disconnect from the task or the team. Hence,

Hypothesis 1b*: The greater the uncertainty in a team member's task, the lower will be that member's task satisfaction.*

When a team member perceives his or her task to be highly uncertain, which hinders the member from allocating resources, scheduling, and prioritizing work, the member tends to feel that he or she is not be able to work efficiently on the task. The member cannot make significant progress on the milestones related to the task. Eventually the member feels that his or her productivity is low. Hence,

Hypothesis 1c*: The greater the uncertainty in a team member's task, the lower will be that member's task productivity.*

According to the information processing theory (Galbraith, 1974), when task uncertainty

increases, more information needs to be processed. In such circumstances, either the amount of information to be processed must be reduced or the capacity to handle more information must be increased. An assumption of the theory is that the ability to handle non-routine, consequential events which cannot be anticipated and planned for in advance will limit information processing because of the communication load inherent in non-programmed events.

Daft and Lengel (1986) applied this assumption to media richness theory. They asserted that to alleviate and mitigate task uncertainty, employees should adopt real-time media in their communication to achieve a high level of task confidence. Task uncertainty lacks sufficient information and can be overcome by obtaining and sharing the needed information (Dennis & Kinney, 1998). Task uncertainty is usually measured by the degree of problem routinization (Lamberti & Wallace, 1990). This means that routine problems or low-uncertainty tasks can be dealt with by a rule or standardized procedure, whereas non-routine problems or high-uncertainty tasks usually require individual attention and greater information processing.

In media richness theory, specific structural mechanisms can be implemented by organizations to facilitate the amount of information needed to cope with uncertainty. Communication transactions that clarify ambiguous issues and change understanding in a timely manner are considered rich. Synchronous collaboration tools are information technologies with the capacity to capture and process rich information among users. These media allow immediate feedback, the number of cues utilized, personalization, and language variety, compared to asynchronous tools that process fewer cues and restrict feedback. While

asynchronous information technologies are more effective for processing well understood messages and standard data, synchronous technologies can provide the capacity to process complex and subjective messages (Dennis et al., 2008).

Therefore, it can be assumed in this study that the influence of task uncertainty on task outcomes will be moderated by the usage of synchronous collaboration technologies that allow immediate feedback, a large number of cues, personalization, and language variety such that the team member with high task uncertainty will have better perceptions on task knowledge sharing, satisfaction, and productivity. However, the usage of asynchronous collaboration technologies, which are more effective for processing well understood messages and standard data, will not influence the relationship between task uncertainty and task outcomes as much as the usage of synchronous collaboration technologies.

In hypothesis 1a, it is hypothesized that when a team member's task is highly uncertain, causing difficulties in planning resource allocations, task schedules, and task priorities, knowledge sharing is necessitated. However, in the situation that a face-to-face meeting is not an option, by using synchronous collaboration technologies that allow immediate feedback, the number of cues utilized, personalization, and language variety, the team member can easily discuss the problems and get solutions related to the task from other team members. The team member easily contacts other team members about his or her task when needed. The team member easily shares success and failure experiences related to the task with other team members. Also, the team member feels comfortable in seeking help related to the task from other team members.

On the other hand, by using an asynchronous collaboration technology that allows an

exchange of information in which the team members receive the information at different times, the dispersed team member cannot perceive significant benefits when discussing the problems or getting solutions related to the uncertain task from other team members, nor feel comfortable seeking help from unfamiliar team members. Hence, we hypothesize,

Hypothesis 2a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task uncertainty and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*

According to hypothesis 1b, when a team member perceives his or her task as highly uncertain, this causes difficulties in planning and allocating resources, which would lead to the member not being satisfied with the task. By using synchronous collaboration technologies in communicating with his or her dispersed team, however, a team member will find it easy to get help related to the task from the project leader or other team members when needed. This positively influences the member's feeling of belonging with the organization or the team. Thus, the member's satisfaction with his or her task will be higher.

By using asynchronous collaboration technologies which are more effective for processing well understood messages and standard data rather than complex and subjective messages in the communication within a geographically dispersed team, the team member is expected to find it difficult to discuss his or her task issues with other team members when needed or get spontaneous cues about their attitudes. Overall, the member's satisfaction with the task remains low. Thus,

Hypothesis 2b*: Use of synchronous collaboration technologies to work with other team*

members will moderate the relationship between task uncertainty and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.

According to hypothesis 1c, when a team member perceives the project task as highly uncertain, the member feels that he or she is not be able to work efficiently on the task. By using synchronous collaboration technologies to communicate with the other team members who are situated in different locations, the member can however alleviate task uncertainty and achieve a high level of task confidence. As a result, the member completes a large number of sub-tasks related to the task within assigned deadlines. The member works more efficiently on the task and finally feels that the task is productive.

By using an asynchronous collaboration technology to communicate with the other team members who are potentially dispersed geographically, the member is expected not to make significant progress related to the task due to the limitation of the technologies in processing the instantaneous and greater amount of information required to perform the task. The member cannot work efficiently on the uncertain task and finally still perceives that the task is not productive. Hence,

Hypothesis 2c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task uncertainty and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*

Task Equivocality

Task equivocality refers to the degree to which work to be performed is vague or confusing. Weick (1979) stated that the basic materials on which organizations operate are

informational inputs that are equivocal, thus there are many possibilities or sets of outcomes that might occur. An organization attempts to transform such equivocal information into sensible outputs. According to Daft and Lengel (1986), high equivocality in organizational tasks leads to confusion and lack of understanding by participants. Employees are not certain about what questions to ask or what clear answers to define for the task at hand. Thus, in this study when the project task becomes more equivocal, the team member's perceptions on task knowledge sharing, satisfaction, and productivity are expected to be impacted.

When a team member deals with ill-defined, ad-hoc, or non-routine business problems of a task, the member tends to have ambiguity or conflicting interpretations about the task. To discuss problems and to get solutions related to the task in consultation other team members become essential. Likewise, it is important to share success and failure experiences related to the task with other team members, and seek their help. Such interactions correspond with greater knowledge sharing. Thus,

Hypothesis 3a: *The greater the equivocality in a team member's task, the greater will be that member's task knowledge sharing.*

When the team member deals with an ill-defined, ad-hoc, or non-routine task, causing an ambiguity or conflicting interpretations about the task, the member is expected not to be satisfied with the task. The member finds it difficult to discuss the task with other team members because he or she is not certain about what questions to ask or what answers to believe. Thus,

Hypothesis 3b: *The greater the equivocality in a team member's task, the lower will be that*

member's task satisfaction.

When a team member perceives his or her project task as highly equivocal and there is ambiguity about the task, the member tends to feel that he or she is unable to work efficiently on the task. Each day the member cannot make sufficient progress related to the task because his or her efforts are likely based on trial and error. In the end, the member believes that he or she is not productive on the task. Thus,

Hypothesis 3c: *The greater the equivocality in a team member's task, the lower will be that member's task productivity.*

Typically, efforts to solve equivocality involve two or more people (Weick, 1979). To alleviate and mitigate task equivocality among employees, they should employ real-time media in their communication to achieve a high level of task confidence (Daft & Lengel, 1986). In organizations, equivocality leads to a challenge for employees to reach the same meaning of the information. Task equivocality can be reduced by exchanging existing views among employees to define problems and resolve conflicts through the enactment of a shared interpretation that can reach agreement and direct future activities. Employees gather data that can be combined with discussions and judgments to reduce equivocality.

In media richness theory, specific structural mechanisms can be implemented by organizations to process rich information by enabling debate, clarification, and enactment to reduce equivocality. Therefore, it can be assumed in this study that the influence of task equivocality on task outcomes will be moderated by the usage of synchronous collaboration technologies that allow immediate feedback, a large number of cues, personalization, and

language variety such that the team member with high task equivocality will have better perceptions on task knowledge sharing, satisfaction, and productivity. However, the usage of asynchronous collaboration technologies, which are more effective for processing well understood messages and standard data, will not influence the relationship between task equivocality and task outcomes as much as the usage of synchronous collaboration technologies.

According to hypothesis 3a, when the team member's task is highly equivocal, knowledge sharing with other team members is not easy. However, in the situation that a face-to-face meeting is not an option, by using synchronous collaboration technologies that allow immediate feedback, the cues utilized, personalization, and language variety, the team member can easily discuss task-related problems and get solutions from other team members. The team member can easily contact other team members about the task when needed. The team member can easily share success and failure experiences related to the task with other team members. The team member feels comfortable in seeking help related to the task from other team members because of the immediacy of cues and the greater likelihood of building a rapport. However, by using asynchronous collaboration technologies that allow exchange of information at different times, the dispersed team member cannot perceive significant benefits when discussing problems or getting solutions related to the equivocal task from other team members. Hence,

Hypothesis 4a: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*

According to hypothesis 3b, when the team member perceives his or her task as highly equivocal, this causes ambiguity or conflicting interpretations about the task, due to which the member does not feel satisfied with the task. By using synchronous collaboration technologies in communication within his or her team, however, the member can find it easy to discuss task issues with other team members when needed. Overall, the member's satisfaction with the task will be higher.

By using an asynchronous collaboration technology that is more effective for processing well understood messages and standard data than complex and subjective while communicating within a dispersed team, the team member is expected to find it difficult to discuss task problems with other team members when needed. Overall, the member's satisfaction with the task cannot be significantly improved. Hence,

Hypothesis 4b: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*

According to hypothesis 3c, when a project team's member perceives his or her task as highly equivocal, the member feels that he or she is not be able to work efficiently on the task. By using synchronous collaboration technologies to communicate with other team members situated in different locations, however, the member can gather data from discussions and judgments to reduce equivocality and reach a shared meaning about the information. These synchronous tools can transform equivocal information into sensible outputs. The team member can complete a large number of sub-tasks related to the task by using such

synchronous tools for equivocal tasks. The member is able to work more efficiently on the task and feels that the task is productive.

In contrast, by using asynchronous collaboration technologies to communicate with other team members situated in different locations, however, a member is expected not to complete in a timely manner as many sub-tasks related to the task due to limitations of asynchronous technologies in instantaneously exchanging opinions amongst employees to perform tasks. Thus, the member cannot work efficiently on the equivocal task. The member finally perceives that the task is not productive. Hence,

Hypothesis 4c: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*

Task Interdependence

According to Thompson (1967), the three types of interdependence, i.e., pooled, sequential, and reciprocal, contain increasingly degrees of contingency, resulting in increasing difficulty in coordination. With pooled interdependence, action in each unit can proceed without regard to action in other units so long as the overall organization remains viable. With sequential interdependence, however, each unit in the set must be readjusted if any one of them acts improperly or fails to meet expectations. With reciprocal interdependence, the actions of each unit in the set must be adjusted to the actions of one or more others in the whole set.

The theory of task interdependence in organizational structure by Thompson (1967) can

be applied to team task interdependence in this study. Task interdependence in this study refers to the degree to which work to be performed depends on each team member to accomplish it. An action by a team member may force adaptation by others. As task interdependence embedded in a team becomes more complex, team can face significant challenges for task success, compared to a team with pooled or independent interdependence. Therefore, it can be hypothesized that the team member's task outcomes are contingent upon the level of task interdependence in the way that the more complex task interdependence will relate to the lower level of team member's perceptions on task knowledge sharing, satisfaction, and productivity.

When a task requires frequent coordination or communication with dispersed team members to get the task done, or a task relatively depends on the performance of other members in the team, causing uncertainty about the task, sharing knowledge becomes necessary especially as the interdependency of tasks increases. Thus,

Hypothesis 5a*: The greater the interdependence in a team member's task, the greater will be that member's task knowledge sharing.*

When a team member has to coordinate with other members to get the task done, he or she is expected not to be satisfied with the task particularly if other members cannot deliver their jobs as scheduled or of the quality that the member expects. Thus,

Hypothesis 5b*: The greater the interdependence in a team member's task, the lower will be that member's task satisfaction.*

When a team member has to coordinate with other members to get the task done, the member feels that he or she is not be able to work efficiently on the task if other members cannot deliver their jobs as scheduled or of the quality that the member expects. If these problems persist, each day the member cannot complete the requisite sub-tasks related to the primary task. In the end, the member can conclude that the task is not productive. Thus,

Hypothesis 5c*: The greater the interdependence in a team member's task, the lower will be that member's task productivity.*

Daft and Lengel (1986) incorporated the construct of task interdependence from Thompson (1967) into the media richness theory. They stated that interdependence increases uncertainty and hence more information must be processed and frequent interactions are needed to accomplish tasks. Consequently, as task interdependence increases, more elaborate collaboration mechanisms are required to connect employees to achieve their tasks. Synchronous collaboration technologies can be mechanisms to coordinate the efforts of individuals working on highly interdependent tasks so as to yield positive outcomes, whereas asynchronous collaboration technologies that are regarded effective in collaboration tasks that have low interdependence should not significantly affect the relationship.

Sharma and Yetton (2003) also supported interdependence arguments of Thompson (1967). They concluded that task interdependence can have an important role in shaping organizational collaboration mechanisms. From prior literature, they summarized that high interdependent tasks, which involve multiple end users performing specific tasks, require high levels of information exchange to clarify task assignments, develop effective task

performance strategies, make decisions, and obtain performance feedback.

Therefore, it is hypothesized in this study that influence of task interdependence on task outcomes will be moderated by the usage of synchronous collaboration technologies such that the team member whose task is highly interdependent with other members of the team will have higher perceptions of task knowledge sharing, satisfaction, and productivity. However, the usage of asynchronous collaboration technologies will not influence the relationship between task interdependence and task outcomes as much as the usage of synchronous collaboration technologies.

According to hypothesis 5a, when a member's task requires frequent coordination or communication with several other team members to get the task done, or the task relatively depends on the performance of other members in the team, causing uncertainty about the task, knowledge sharing about the task becomes necessary. Using synchronous collaboration technologies that provide instantaneous information exchange, the team member is easily able to discuss problems and get solutions related to the task from other team members. The team member easily contacts other team members about the task when needed. The team member easily shares success and failure experiences related to the task with other team members. Also, the team member feels comfortable in seeking help related to the task from other team members.

By using asynchronous collaboration technologies that allow an exchange of information in which the team members receive the information at different times, the dispersed team member will not perceive significant benefits when discussing the problems or getting solutions related to the task from other team members. The team member still finds it difficult

to contact other team members about the task when needed. Hence,

Hypothesis 6a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*

According to hypothesis 5b, when a team member perceives his or her task as highly interdependent, it causes uncertainty about the task, and leads the member to not be satisfied with the task. By using synchronous collaboration technologies while communicating with his or her dispersed team, the member can find it easy to talk related issues with other team members when needed. With the abilities to provide high levels of information exchange, these tools instantly facilitate the volume and precision of information needed to eliminate confusion and lack of understanding of participants. The ambiguous issues can be clarified and understanding can be changed in a timely manner. As a result, the member's satisfaction with the task will be higher.

By using asynchronous collaboration technologies that are more effective for processing simpler messages and standard data rather than complex and subjective messages while communicating with his or her team, the member cannot easily eliminate confusion and lack of understanding of the task occurred from interdependence. The ambiguous issues are not easily clarified and shared understanding is not reached in a timely manner. Hence,

Hypothesis 6b*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*

According to hypothesis 5c, when a dispersed team member perceives his or her task as highly interdependent, the member feels that he or she is not be able to work efficiently on the task. By using synchronous collaboration technologies to communicate with other team members situated in different locations, however, the member can obtain the amount of information needed to cope with uncertainty. The team member is able to complete a large number of sub-tasks related to the primary task by using synchronous collaboration tools. The member can thus work more efficiently on the task and finally feel that the task is productive.

By using asynchronous collaboration technologies to communicate with other team members situated in different locations, a member is expected not to be able to complete a significantly large number of sub-tasks related to the primary task due to the limitation of the technology in instantly exchanging opinions amongst the team to perform tasks. The member cannot work efficiently on the task and finally perceives that the task is not productive. Hence,

Hypothesis 6c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*

Task Differentiation

In this study, task differentiation refers to the degree to which work to be performed is divided into smaller segments on some reasonable basis (Walton, 1980). Such differentiation influences equivocality, especially in the task that is divided into smaller subtasks and such subtasks require several team members to provide an output. Interpersonal communications

thus can be complex, ambiguous, and difficult to interpret. When a team member's task is greatly differentiated, the team member's perceptions on task knowledge sharing, satisfaction, and productivity are expected to be affected.

When a team member has a large number of tasks to perform or his or her task constitutes a small part of the overall work process, causing equivocality about the task due to complex communication with the rest of the team members, knowledge sharing becomes essential. To discuss problems and to get solutions related to the task with several other team members are especially necessary when tasks are highly differentiated. Sharing success and failure experiences and obtaining help from other members help overcome the problems associated with differentiation. Hence,

Hypothesis 7a*: The greater the differentiation in a team member's task, the greater will be that member's task knowledge sharing.*

Likewise, when a team member has a large number of tasks to perform or his or her task constitutes a small part of the overall work process, the member may not be satisfied with the task. This is especially true when the task is divided into smaller subtasks and such subtasks require several team members to provide an output, potentially leading to greater equivocality. He or she feels difficult to get help related to the task from other team members when needed. Hence,

Hypothesis 7b*: The greater the differentiation in a team member's task, the lower will be that member's task satisfaction.*

When a team member has a large number of tasks which require several team members to provide an output or his or her task constitutes a small part of the overall work process, the member feels that he or she is not be able to work efficiently on the task. Whenever a task relatively depends on the performance of other members in the team, the member feels that he or she is not be able to work efficiently on the task if other members cannot perform their jobs well. If these problems persist, each day the member cannot complete a large number of things related to the task. In the end, the member perceives that the task is not productive. Therefore,

Hypothesis 7c*: The greater the differentiation in a team member's task, the lower will be that member's task productivity.*

In media richness theory, Daft and Lengel (1986) proposed that rich media can resolve coordination problems for tasks that are highly differentiated. Organizations use structural mechanisms that permit coordinated action across large numbers of differentiated roles on a particular task. The structural mechanisms developed by organizations should enable participants to confront and resolve disagreement and misunderstanding that can arise.

Collaboration technologies utilized by project teams can enable the members to process their highly differentiated tasks and make mutual adjustments, whereas standardized rules and operating procedures can help in coordinating tasks with low differentiation (Galbraith, 1974).

Therefore, it is hypothesized in this dissertation that the influence of task differentiation on task outcomes will be moderated by the usage of synchronous collaboration technologies

such that the team member with high task differentiation will have higher positive perceptions of task knowledge sharing, satisfaction, and productivity. However, the usage of asynchronous collaboration technologies will not influence the relationship between task differentiation and task outcomes as much as the usage of synchronous collaboration technologies.

According to hypothesis 7a, when a team member has a large number of tasks to perform or his or her task constitutes a small part of the overall work process, causing equivocality about the task, greater knowledge sharing is required. However, in the situation that a face-to-face meeting is not an option, by using a synchronous collaboration technology which provides immediate feedback, cues, personalization, and language variety, the team member should be able to easily discuss problems and get solutions related to the task from other team members. The team member will be able to easily contact other team members about the task when needed. The team member will also be able to easily share success and failure experiences related to the task with other team members. Also, the team member will feel comfortable in seeking help related to the task from other team members because of the rapport facilitated by same-time communication. In contrast, by using asynchronous collaboration technologies that allow exchange of information at different times, the dispersed team member does not perceive significant benefits for discussing problems or getting solutions related to the task from other team members. Thus,

Hypothesis 8a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*

According to hypothesis 7b, when a team member perceives his or her task as being highly differentiated, it causes equivocality about the task, and the member is expected not be satisfied with the task. In contrast, by using synchronous collaboration technologies in communicating with his or her dispersed team, however, a team member finds it easy to discuss problems associated with the task with other team members when needed. He or she could thus mitigate equivocality from task differentiation. With the abilities to provide high volumes of information exchange, the synchronous collaboration tools can instantly communicate the information needed to eliminate confusion and lack of understanding of participants. The ambiguous issues can be clarified and understanding can be changed in a timely manner. As a result, the member's satisfaction with the task is higher.

In contrast, by using asynchronous collaboration technologies that are more effective for processing simpler messages and standard data rather than complex and subjective messages, the team member will still find it difficult to discuss task issues or eliminate confusion and lack of understanding about the task when communicating with the team. Shared understanding cannot be reached in a timely manner. As a result, the member's satisfaction with the task is not significantly improved. Thus,

Hypothesis 8b*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*

In the hypothesis 7c, it was hypothesized that when a dispersed team member perceives his or her task as highly differentiated, the member feels that he or she is not be able to work

efficiently on the task. Interpersonal communication with other team members on the task can be complicated. By using synchronous collaboration technologies to communicate with other team members who are situated in different locations, however, the member can gather data from discussions and judgments to reduce equivocality and reach the same meaning about the information. The team member can complete a large number of sub-tasks related to the task by using a synchronous collaboration tool. The member works more efficiently on the task and finally feels that the task is productive.

In contrast, by using asynchronous collaboration technologies to communicate with other team members situated in different locations, a member cannot be able to complete a significantly large number of sub-tasks related to the primary task within a timely manner due to the limitation of asynchronous technologies in instantly exchanging opinions among employees to perform tasks. The member cannot work efficiently on the task and finally perceives that the task is not significantly productive. Thus,

Hypothesis 8c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*

The 24 hypotheses discussed above are summarized in Table 1.

Task Uncertainty
Direct Effects
Hypothesis 1a*: The greater the uncertainty in a team member's task, the greater will be that member's task knowledge sharing.*
Hypothesis 1b*: The greater the uncertainty in a team member's task, the lower will be that member's task satisfaction.*
Hypothesis 1c*: The greater the uncertainty in a team member's task, the lower will be that member's task productivity.*
Moderating Effects
Hypothesis 2a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task uncertainty and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*
Hypothesis 2b*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task uncertainty and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*
Hypothesis 2c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task uncertainty and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*
Task Equivocality
Direct Effects
Hypothesis 3a: *The greater the equivocality in a team member's task, the greater will be that member's task knowledge sharing.*
Hypothesis 3b: *The greater the equivocality in a team member's task, the lower will be that member's task satisfaction.*
Hypothesis 3c: *The greater the equivocality in a team member's task, the lower will be that member's task productivity.*
Moderating Effects
Hypothesis 4a: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*
Hypothesis 4b: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*
Hypothesis 4c: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*

Task Interdependence
Direct Effects
Hypothesis 5a*: The greater the interdependence in a team member's task, the greater will be that member's task knowledge sharing.*
Hypothesis 5b*: The greater the interdependence in a team member's task, the lower will be that member's task satisfaction.*
Hypothesis 5c*: The greater the interdependence in a team member's task, the lower will be that member's task productivity.*
Moderating Effects
Hypothesis 6a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*
Hypothesis 6b*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*
Hypothesis 6c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*
Task Differentiation
Direct Effects
Hypothesis 7a*: The greater the differentiation in a team member's task, the greater will be that member's task knowledge sharing.*
Hypothesis 7b*: The greater the differentiation in a team member's task, the lower will be that member's task satisfaction.*
Hypothesis 7c*: The greater the differentiation in a team member's task, the lower will be that member's task productivity.*
Moderating Effects
Hypothesis 8a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*
Hypothesis 8b*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*
Hypothesis 8c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*

Table 1: Hypotheses

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 Research Design

In order to answer the research questions and identify relationships among task characteristics, synchronous and asynchronous collaboration technology usage, and task outcomes, a cross-sectional research design was deemed appropriate. Thus, a survey questionnaire was used to collect perceptual data from employees of multiple organizations on their team project tasks, collaboration technology usage, and task outcomes to empirically examine the relationships between the constructs in the research model.

4.2 Measures

Measures of all constructs in this study were obtained from prior research to the greatest extent possible in order to enhance validity. The words in the questions were though modified to suit the context of the current study. The verb tense (present or past tense) in the adapted questionnaire items was selected based on whether the team project was on-going or completed. The items in task characteristics and task outcomes were measured using a five-point scale that ranged from 1 (strongly disagree) to 5 (strongly agree). The items in collaboration technology usage were also measured using a five-point scale that ranged from 1 (never) to 5 (almost always). A summary of measures, including the original and adapted questionnaire items, can be seen in Table 2 with reverse coded items marked with an (R).

Task characteristics included four constructs, i.e., task uncertainty, task equivocality, task interdependence, and task differentiation. The items for task uncertainty were obtained from Rustagi et al. (2008). All four items in the scale measured the degree of a team member's task certainty on an ongoing or recently completed project. Therefore, these items were reverse coded in the subsequent analysis. The items measuring task differentiation were derived from Iloria (2007) and reflected the extent of subdivision of project tasks.

The task equivocality scale was derived from Goodhue and Thompson (1995), and measured the degree of a team member's task puzzlement or confusion on the project. All three items were evaluated in the same direction as their construct definition. Task interdependence was the only construct whose items were derived from multiple sources (Billings et al., 1997; Sharma & Yetton, 2007; Sanders & Courtney, 1985). During the data analysis, some items needed to be reverse coded to follow the same direction as the other items. After reverse coding, all scales of this construct assessed the degree of a team project member's task dependence on other team members.

Both synchronous and asynchronous collaboration technology use items were adapted from Koo et al. (2011). These items reflected a team member's collaboration technology usage during the project with other members for different purposes.

Task outcomes were explained by three constructs: task knowledge sharing, task satisfaction, and task productivity. The knowledge sharing items were adapted from Golden and Raghuram (2010) and reflected the perception of a team member in giving and receiving wisdom and experiences to other project team members about a task through direct or indirect interactions. The task satisfaction items were obtained from Rutner et al. (2008) and measured

the fulfillment or gratification experienced by a project team member towards his or her task during the project. Lastly, the task productivity scale was derived from Ferratt and Argawal (1994) which assessed the perception of a project team member on how efficiently he or she used available resources to produce the task's end-product.

Construct	Adapted Question	Original Question	Reference
Task Uncertainty	TU1: My work is (was) quite routine. (R)	This outsourced IS activity is quite routine and repetitive.	Rustagi et al. (2008)
	TU2: My work is (was) quite repetitive. (R)		
	TU3: My work is (was) quite stable. (R)	Business processes that are most closely associated with this outsourced IS activity are likely to remain fairly stable in the short term.	Rustagi et al. (2008)
	TU4: My work is (was) quite predictable. (R)	Performing this outsourced IS activity is likely to remain fairly predictable in the short term.	Rustagi et al. (2008)
Task Equivocality	TE1: I deal (dealt) with ill-defined business problems for my work.	I frequently deal with ill-defined business problems.	Goodhue and Thompson (1995)
	TE2: I deal (dealt) with ad-hoc, non-routine business problems for my work.	I frequently deal with ad-hoc, non-routine business problems.	Goodhue and Thompson (1995)
	TE3: My work involves (involved) answering questions that I have (had) never been asked before.	Frequently the business problems I work on involve answering questions that have never been asked in quite that form before.	Goodhue and Thompson (1995)
Task Interdependence	TI1: I have (had) to communicate with my team members to get my work done.	I have to talk to other workers to get my job done.	Billings et al. (1977)
	TI2: I can (could) perform my work fairly independently of my team members. (R)	This task can be performed fairly independently of others.	Sharma and Yetton (2007)
	TI3: I can (could) plan my work with little need to coordinate with other team members. (R)	This task can be planned with little need to coordinate with others.	Sharma and Yetton (2007)
	TI4: I am (was) rarely required to obtain information from other team members to complete my work. (R)	It is rarely required to obtain information from others to complete this task.	Sharma and Yetton (2007)
	TI5: My work is (was) relatively unaffected by the performance of other individuals in the team. (R)	This task is relatively unaffected by the performance of other individuals or departments.	Sharma and Yetton (2007)
	TI6: My work requires (required) frequent coordination with the efforts of other individuals in the team.	This task requires frequent coordination with the effort of others.	Sharma and Yetton (2007)

Construct	Adapted Question	Original Question	Reference
	TI7: My work performance depends (depended) on receiving accurate information from other team members.	Performance on this task is dependent on receiving accurate information from others.	Sharma and Yetton (2007)
	TI8: I work (worked) independently of other team members to accomplish the assigned work. (R)	To what extent do you have a one-person job? That is, to get your work out, to what extent do you work independently of others to accomplish your assigned tasks?	Sanders and Courtney (1985)
	TI9: I meet (met) with other team members to discuss how my work should be performed or treated.	To what extent do you meet with your colleagues to discuss how each task, case, or claim related to your work should be performed or treated?	Sanders and Courtney (1985)
Task Differentiation	TD1: I have (had) a small number of tasks to perform in my work.	Posts in the production area have a reduced number of tasks to perform.	Iloria (2007)
	TD2: My work is (was) largely uncomplicated.	Tasks carried out in the area of production are largely uncomplicated.	Iloria (2007)
	TD3: My work constitutes (constituted) a small part of the overall work process of the team.	Tasks carried out in the area of production constitute a small part of the overall work process.	Iloria (2007)
	TD4: My work is (was) largely unvaried.	Tasks carried out in the area of sales are largely unvaried.	Iloria (2007)
Synchronous Collaboration Technology Use	SU1: I use (used) same-time collaboration tools to discuss work-related subjects with other team members.	I usually use *** to discuss some task-related subjects.	Koo et al. (2011)
	SU2: I use (used) same-time collaboration tools to discuss ideas with other team members.	I usually use *** to discuss an idea, procedure and policy.	Koo et al. (2011)
	SU3: I use (used) same-time collaboration tools to discuss procedures with other team members.		
	SU4: I use (used) same-time collaboration tools to discuss policies with other team members.		

Construct	Adapted Question	Original Question	Reference
	SU5: I use (used) same-time collaboration tools to arrange schedules with other team members.	I usually use *** to arrange schedule and share information.	Koo et al. (2011)
	SU6: I use (used) same-time collaboration tools to share information with other team members.		
	SU7: I use (used) same-time collaboration tools to find solutions for difficult team problems.	I usually use *** to find some difficulty solutions and to solve sensitive issue in the organization.	Koo et al. (2011)
	SU8: I use (used) same-time collaboration tools to solve sensitive issues in my team.		
Asynchronous Collaboration Technology Use	AU1: I use (used) different-time collaboration tools to discuss work-related subjects with other team members.	I usually use *** to discuss some task-related subjects.	Koo et al. (2011)
	AU2: I use (used) different-time collaboration tools to discuss ideas with other team members.	I usually use *** to discuss an idea, procedure and policy.	Koo et al. (2011)
	AU3: I use (used) different-time collaboration tools to discuss procedures with other team members.		
	AU4: I use (used) different-time collaboration tools to discuss policies with other team members.		
	AU5: I use (used) different-time collaboration tools to arrange schedules with other team members.	I usually use *** to arrange schedule and share information.	Koo et al. (2011)
	AU6: I use (used) different-time collaboration tools to share information with other team members.		
	AU7: I use (used) different-time collaboration tools to find solutions for difficult team problems.	I usually use *** to find some difficulty solutions and to solve sensitive issue in the organization.	Koo et al. (2011)
	AU8: I use (used) different-time collaboration tools to solve sensitive issues in my team.		
Task Knowledge Sharing	TK1: I discuss (discussed) problems and solutions related to my work with other team members.	In my work group we discuss work-related problems and solutions.	Golden and Raghuram (2010)

Construct	Adapted Question	Original Question	Reference
	TK2: I can (could) easily contact other team members about my work when needed.	I can easily contact those who can help me when I need them.	Golden and Raghuram (2010)
	TK3: I share (shared) success and failure experiences related to my work with other team members.	In my work group, we share work-related success and failure experiences.	Golden and Raghuram (2010)
	TK4: I get (got) solutions to my work problems from other team members.	I can get solutions to problems from people who work from other locations.	Golden and Raghuram (2010)
	TK5: I feel (felt) comfortable in seeking help related to my work from other team members.	I feel comfortable in seeking help from people in my group.	Golden and Raghuram (2010)
Task Satisfaction	TS1: Generally speaking, I feel (felt) satisfied with my work.	Generally speaking, I feel satisfied with this job.	Rutner et al. (2008)
	TS2: Overall, I feel (felt) satisfied with the kind of work I do in this project.	Overall, I feel satisfied with the kind of work I do in this job.	Rutner et al. (2008)
	TS3: In general, I feel (felt) satisfied with the work assigned to me.	In general, I feel satisfied with my job.	Rutner et al. (2008)
Task Productivity	TP1: I rate the amount of work I complete (completed) as being outstanding.	The amount of work this employee completes is: less than it should be to outstanding (scale from 1 to 7).	Ferratt and Argawal (1994)
	TP2: I rate the amount of time it takes (took) me to complete my assigned work as being outstanding.	The amount of time it takes this employee to complete assigned work is: less than it should be to outstanding (scale from 1 to 7).	Ferratt and Argawal (1994)
	TP3: I rate the quality of my work as being outstanding.	The quality of this employee's work is: less than it should be to outstanding (scale from 1 to 7).	Ferratt and Argawal (1994)
	TP4: I rate my record of completing work on time (i.e., not being late in meeting assigned deadlines) as being outstanding.	This employee's record of completing work on time (for example, not being late in meeting assigned deadlines) is: less than it should be to outstanding (scale from 1 to 7).	Ferratt and Argawal (1994)

Table 2: Construct Measurements

4.3 Data Collection

Since this study aimed to understand the behavior of the individual team members on their project team task, collaboration technologies used for the task, and task outcomes, the unit of analysis was the individual. Even though the study on a macro level spanned multiple technologies and types of users in organizations, the targeted participants had to employ at least one synchronous and one asynchronous collaboration technology in their communication with other team members. The range of the collaboration technologies was defined by providing respondents definitions of various synchronous and asynchronous technologies and the manner in which each technology was typically used to ensure common understanding. In addition, the focal project was required to have electronic interaction and exclusive virtuality in team communication to avoid bias from face-to-face interaction. Data were collected directly from project team members during an ongoing project or after the completion of a recent project.

The survey instrument included sections designed to collect information on a project selected by the respondent, along with collaboration technologies and their usage during the project; task characteristics and outcomes for the selected project; a marker variable to assess the common method bias; and demographics. The definition of synchronous and asynchronous collaboration technologies was provided in the instructions section of the instrument (see Appendix B). Respondents were also asked to indicate whether they had recently participated on a team project using at least one synchronous and one asynchronous collaboration tool before starting filling out the questionnaire. At the end of the survey, respondents were provided the opportunity to leave comments.

4.4 Pretest and Pilot Test

For a preliminary trial of the psychometric aspects of the instrument to ensure that there were no unanticipated difficulties at the time of data collection, a pretest was conducted. In the pretest, the questionnaire was administered during face-to-face interviews with 19 voluntary participants who were practitioners at various organizations in a Midwestern metropolitan city. The interviewers were conducted either at the participant's workplace or a mutually agreed upon venue. These participants had on average 10 years of experience in their current role. They were asked to complete an online questionnaire and provided the opportunity to comment on any aspect of the questionnaire. Feedback was obtained about the length and layout of the questionnaire, format of the scales, content validity, and question ambiguity. In addition, the respondents were asked to identify any important factors that did not or should appear on the questionnaire. Changes were made to the questionnaire after each interview. The pretest was conducted over a period of 6 months from May to October 2013. It concluded when no more concerns were found by the participants. The results of the pretest indicated high content validity of the instrument.

Next, a pilot test was conducted using a convenience sample of students enrolled in a professional MBA class in a public university in a Midwest metropolitan city. A total of 15 respondents participated in the pilot study. The data obtained from the pilot was examined for completeness, reliability, and construct validity. Subsequently, some minor changes were made to the questionnaire.

4.5 Sample

The sample was acquired from various organizations located in a Midwestern U.S. city. High-level executives of these organizations were contacted by an introductory e-mail letter describing the study, explaining benefits and risks involved, and eliciting their participation so that they would urge their project team members to participate in the survey. These project team members were asked to sign a consent form (Appendix A), read and understand the survey questionnaire instructions, and finally complete the survey. They were required to have intimate knowledge (self-reportedly) of their task in an ongoing or recently completed project that used at least one synchronous and one asynchronous collaboration technology as the main communication tools among team members who worked in different physical spaces or in different time zones.

In total, the survey was sent out to 2,163 employees. To stimulate responses, one dollar was promised as a contribution to United Way, a non-profit charity organization, for each valid response. Participants were also offered an opportunity to be informed of the results. There were 250 returned responses (11.5%). After close examination of the returned questionnaires, 161 responses (7.4%) were finally identified as being valid for subsequent analysis. The main reason of the dropped responses came from the participants who did not employ both synchronous and asynchronous collaboration tools in their selected project. Tables 3 and 4 show the respondent characteristics and their selected project characteristics.

The majority of respondents' ages ranged from 30-39 years (43.4%) and 40-49 years (28.9%). There were 40.9% women and 59.1% men. Most respondents had a college degree (92.4%). Their job tenures ranged from less than 1 year to 32 years (mean = 7.7 and standard

deviation = 6.5). The number of project team members ranged from 2 to 200 members (mean = 16 and standard deviation = 23). The project tenures ranged from less than 1 month to 5 years (mean = 10.2 months and standard deviation = 10.7 months). About one third of the projects (34.8%) were completed, while the rest (65.2%) were still on-going. To collaborate with other team members, the respondents used a variety of synchronous collaborations tools, including audio conferencing (22.59%), video conferencing (7.22%), web conferencing (22%), instant messaging (22.59%), and telephone (24.07%). They rated their ability with these tools fairly high (60% good and 23.1% excellent). The major asynchronous collaboration tool was e-mail (56.23%). Most respondents rated their ability with all asynchronous collaboration tools between average to good (77.5%). They utilized these collaboration tools for the selected project within different organizational departments. Tables 3 and 4 summarize the demographic characteristics of the sample.

Age	
Under 30	8.7%
30-39	43.5%
40-49	29.2%
50-59	16.1%
60 and over	2.5%
Gender	
Female	41.3%
Male	58.7%
Completed Level of Education	
Diploma or Less	3.7%
Associate Degree (2 Years)	2.5%

Completed Level of Education	
Undergraduate Degree	32.3%
Masters Degree	53.4%
Doctoral Degree	6.8%
Other	1.2%
Years in Company	
Mean	7.6 Years
S.D.	6.5 Years
Minimum	Less than 1 Year
Maximum	32 Years

Table 3: Respondent Characteristics

Project Team Members	
Mean	16
S.D.	23
Minimum	2
Maximum	200
Project Duration in Months	
Mean	10.2
S.D.	10.7
Minimum	Less than 1 Month
Maximum	60 Months
Project Status	
Completed	34.5%
On-Going	65.5%
Synchronous Collaboration Tools	
Audio Conferencing	22.59%
Video Conferencing	7.22%
Web Conferencing	22%

Synchronous Collaboration Tools	
Instant Messaging	22.59%
Telephone	24.07%
Other	1.48%
Ability with Synchronous Collaboration Tools	
Poor	0%
Fair	1.2%
Average	15.5%
Good	59.6%
Excellent	23.6%
Asynchronous Collaboration Tools	
E-Mail	56.23%
Fax	2.49%
Discussion Board	9.61%
Wiki	8.9%
Blog	4.63%
Social Network	8.19%
Microblog	0%
Other	9.96%
Ability with Asynchronous Collaboration Tools	
Poor	0%
Fair	6.2%
Average	30.4%
Good	47.2%
Excellent	16.1%
Departments	
Accounting	9.97%
Finance	12.61%
Human Resources	5.57%

Departments	
Information Systems	29.33%
Production	12.61%
R&D	8.21%
Sales	8.8%
Other	12.9%

Table 4: Project Characteristics

4.6 Model Measurement

The covariance-based approach of Structural Equation Modeling (SEM) with IBM AMOS 22.0.0 was used to develop the measurement model. This approach can provide optimal estimations of the model parameters if the hypothesized structural and measurement models are indeed correct in explaining the covariation of all the measurement items (Chin, 1998). The objective of using covariance-based SEM in this study was to show that the theoretical model was not disconfirmed by the data. Covariance-based SEM techniques emphasize the overall fit of the hypothesized measurement model, and thus are best suited for testing theoretical models like the current study.

4.6.1 Reliability

The internal consistency of the multi-item scales was assessed by using the composite reliability measure as suggested by Fornell and Larcker (1981). All variables, except task equivocality, exhibited high composite reliability. After dropping the item TE1 (“I deal (dealt) with ill-defined business problems for my work”), which demonstrated the lowest internal consistency of task equivocality, the composite reliability of task equivocality

became 0.68 which was acceptable due to the exploratory nature of the current research (Nunnally, 1978). Table 5 displays composite reliability and number of items for each construct.

Construct	Number of Items	Composite Reliability
Task Uncertainty	4	0.79
Task Equivocality	2	0.68
Task Interdependence	9	0.81
Task Differentiation	4	0.78
Task Knowledge Sharing	5	0.77
Task Satisfaction	3	0.91
Task Productivity	4	0.83
Fashion Consciousness*	3	0.76
Synchronous Collaboration Technology Usage	8	0.83
Asynchronous Collaboration Technology Usage	8	0.81

** Fashion Consciousness items were added to assess the common method bias.*

Table 5: Construct Reliability

4.6.2 Content Validity

Content validity was established by ensuring consistency between the measurement items and the extant literature. Support for content validity in this study was provided by the strong theoretical basis for the items, their prior validation, and from evaluation of the survey content for appropriateness by the 19 voluntary participants during the pretest.

4.6.3 Construct Validity

Construct validity provides an indication of the extent to which an operationalization actually measures the concepts that it purports to measure (Straub, 1989). Apart from the internal consistency, AMOS was also employed to assess two types of construct validity, i.e., convergent and discriminant validity.

4.6.3.1 Convergent Validity

Convergent validity refers to the extent to which a measure is similar to other measures assessing the same phenomenon. Assessing convergent validity was done by verifying that the average variance extracted (AVE) of each construct was larger than its correlations with the other constructs and that each item's loading in the factor analysis was much higher on its assigned construct (factor) than on the other constructs (Gefen et al., 2000). All multi-item reflective constructs should have an AVE of at least 0.50 (Fornell & Larcker, 1981), adequately demonstrating convergent validity. The analysis results showed that the AVE for every variable exceeded 0.5 after dropping the items listed below due to their low construct loadings.

- TU3 ("My work is (was) stable") and TU4 ("My work is (was) quite predictable") from task uncertainty.

- TI1 ("I have (had) to communicate with my team members to get my work done"), TI6 ("My work requires (required) frequent coordination with the efforts of other individuals in the team"), TI7 ("My work performance depends (depended) on receiving accurate

information from other team members", and TI9 ("I meet (met) with other team members to discuss how my work should be performed or treated") from task interdependence.

- TD3 ("My work constitutes (constituted) a small part of the overall work process of the team") from task differentiation

- TK1 ("I discuss (discussed) problems and solutions related to my work with other team members") and TK2 ("I can (could) easily contact other team members about my work when needed") from task knowledge sharing.

- SU1 ("I use (used) same-time collaboration tools to discuss work-related subjects with other team members"), SU3 ("I use (used) same-time collaboration tools to discuss procedures with other team members"), SU4 ("I use (used) same-time collaboration tools to discuss policies with other team members"), SU7 ("I use (used) same-time collaboration tools to find solutions for difficult team problems"), and SU8 ("I use (used) same-time collaboration tools to solve sensitive issues in my team") from synchronous collaboration technology usage.

- AU1 ("I use (used) different-time collaboration tools to discuss work-related subjects with other team members"), AU3 ("I use (used) different-time collaboration tools to discuss procedures with other team members"), AU4 ("I use (used) different-time collaboration tools to discuss policies with other team members"), AU7 ("I use (used) different-time collaboration tools to find solutions for difficult team problems"), and AU8 ("I use (used) different-time collaboration tools to solve sensitive issues in my team") from asynchronous collaboration technology usage.

After dropping the 19 items specified above, the composite reliability and AVE of each construct were recalculated. The results supported both reliability and convergent validity of each construct (See Table 6). The descriptive statistics of the variables included in the analysis can be found in Appendix C.

Construct (AVE)	Composite Reliability	Variables	Loading
Task Uncertainty (0.74)	0.85	TU1: My work is (was) quite routine.	0.74
		TU2: My work is (was) quite repetitive.	0.96
Task Equivocality (0.51)	0.68	TE2: I deal (dealt) with ad-hoc, non-routine business problems for my work.	0.80
		TE3: My work involves (involved) answering questions that I have (had) never been asked before.	0.62
Task Interdependence (0.51)	0.84	TI2: I can (could) perform my work fairly independently of my team members.	0.76
		TI3: I can (could) plan my work with little need to coordinate with other team members.	0.70
		TI4: I am (was) rarely required to obtain information from other team members to complete my work.	0.67
		TI5: My work is (was) relatively unaffected by the performance of other individuals in the team.	0.76
		TI8: I work (worked) independently of other team members to accomplish the assigned work.	0.66
Task Differentiation (0.55)	0.78	TD1: I have (had) a small number of tasks to perform in my work.	0.67
		TD2: My work is (was) largely uncomplicated.	0.81
		TD4: My work is (was) largely unvaried.	0.72
Synchronous Collaboration Technology Use (0.62)	0.82	SU2: I use (used) same-time collaboration tools to discuss ideas with other team members.	0.63
		SU5: I use (used) same-time collaboration tools to arrange schedules with other team members.	0.95
		SU6: I use (used) same-time collaboration tools to share information with other team members.	0.74
Asynchronous Collaboration Technology Use (0.57)	0.79	AU2: I use (used) different-time collaboration tools to discuss ideas with other team members.	0.56
		AU5: I use (used) different-time collaboration tools to arrange schedules with other team members.	0.89
		AU6: I use (used) different-time collaboration tools to share information with other team members.	0.77

Construct (AVE)	Composite Reliability	Variables	Loading
Task Knowledge Sharing (0.52)	0.76	TK3: I share (shared) success and failure experiences related to my work with other team members.	0.79
		TK4: I get (got) solutions to my work problems from other team members.	0.71
		TK5: I feel (felt) comfortable in seeking help related to my work from other team members.	0.65
Task Satisfaction (0.78)	0.91	TS1: Generally speaking, I feel (felt) satisfied with my work.	0.88
		TS2: Overall, I feel (felt) satisfied with the kind of work I do in this project.	0.91
		TS3: In general, I feel (felt) satisfied with the work assigned to me.	0.86
Task Productivity (0.56)	0.84	TP1: I rate the amount of work I complete (completed) as being outstanding.	0.82
		TP2: I rate the amount of time it takes (took) me to complete my assigned work as being outstanding.	0.72
		TP3: I rate the quality of my work as being outstanding.	0.81
		TP4: I rate my record of completing work on time (i.e., not being late in meeting assigned deadlines) as being outstanding.	0.64
Fashion Consciousness (0.52)	0.76	FC1: When I must choose between the two, I usually dress for fashion, not for comfort.	0.68
		FC2: An important part of my life and activities is dressing smartly.	0.75
		FC3: A person should try to dress in style.	0.73

Table 6: Convergent Validity

4.6.3.2 Discriminant Validity

Discriminant validity describes the extent to which a measure is different from other measures assessing different phenomenon. As a rule of thumb, the square root of the AVE of each reflective construct should be much larger than the correlation of the specific construct with any of the other constructs in the model (Chin, 1998) and should be at least .50 (Fornell & Larcker, 1981). Thus the square root of the AVE (shown in the diagonal elements in Table 7) was found to be larger than the correlations between constructs (shown in the off-diagonal

elements of the table), thereby demonstrating discriminant validity of the scales. Moreover, each observed variable had a higher correlation with its own construct compared to its correlation with other variables thereby further establishing discriminant validity.

Construct	AVE	TU	TE	TI	TD	SU	AU	TK	TS	TP	FC
Task Uncertainty (TU)	.74	**.86**									
Task Equivocality (TE)	.51	-.38	**.72**								
Task Interdependence (TI)	.51	.41	-.05	**.71**							
Task Differentiation (TD)	.55	.39	-.37	.53	**.74**						
Synchronous Tech Use (SU)	.62	-.01	.12	-.00	-.09	**.78**					
Asynchronous Tech Use (AU)	.57	.05	.24	.17	-.07	.32	**.75**				
Task Knowledge Sharing (TK)	.52	-.21	.29	-.49	-.14	.18	.05	**.72**			
Task Satisfaction (TS)	.78	-.27	.18	.07	.03	.11	.02	.52	**.88**		
Task Productivity (TP)	.56	0	.32	.10	-.10	.26	.13	.21	.42	**.75**	
Fashion Consciousness (FC)	.52	-.16	.14	-.15	.01	.21	.10	.35	.18	.11	**.72**

Table 7: Discriminant Validity

4.6.4 Model Fit

AMOS provided a series of indices that were utilized to assess whether the data conformed to the hypothesized model. Based on the values of these indices, the research model in this study demonstrated good fit (Gefen et al., 2000; Taylor & Todd, 1995). The chi-square divided by degree of freedom (CMIN/DF) was less than 3. The root mean square residual (RMR) was lower than .05. The comparative fit index (CFI) was excellent at .95. The root mean square of approximation (RMSEA) was lower than 0.08. The completed model fit summary during the confirmatory factor analysis (CFA) and in the structural model can be found in Appendix D.

4.6.5 Common Method Bias

Common method bias (CMB) or common method variance (CMV) is the "variance that is attributable to the measurement method rather than to the constructs the measures represent" (Podsakoff et al., 2003, p.879). It can be an issue for data that is through only one method (Campbell & Fiske 1959) such as a survey conducted at a single point in time. Three different methods were employed in this study to assess whether common-method bias was an issue. Firstly, Harman's one-factor statistical test was conducted in SPSS 22.0. An exploratory factor analysis was performed that included all the items used to measure the constructs in the research framework. The results of factor analysis generated neither a single factor nor a general factor which would indicate a problem. Furthermore, the first factor that emerged from the exploratory factor analysis did not account for a large percent of the variance (17.16%), suggesting that common-method bias was not a threat in the study. Table 8 displays Harman's one-factor statistical test results.

Because Harman's single factor test can detect only the most severe cases of bias, assessing common method bias with a common latent factor (CLF) has become a popular alternate method that seeks to capture the common variance amongst all observed variables in the research model. For the test, a latent factor was added to the AMOS CFA model with paths to all observed items in the model. There were no large differences (< 0.2) between the standardized regression weights of the research model with CLF and without CLF, confirming that common-method bias did not influence the responses. Table 9 displays the CLF test results.

Total Variance Explained						
Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.32	17.16	17.16	5.32	17.16	17.16
2	4.27	13.77	30.93			
3	2.67	8.61	39.54			
4	2.21	7.11	46.66			
5	1.92	6.19	52.85			
6	1.73	5.57	58.42			
7	1.50	4.83	63.25			
8	1.33	4.30	67.55			
9	1.15	3.72	71.27			
10	.81	2.62	73.88			
11	.74	2.40	76.28			
12	.67	2.16	78.44			
13	.61	1.96	80.41			
14	.59	1.90	82.31			
15	.55	1.76	84.07			
16	.53	1.71	85.78			
17	.49	1.59	87.36			
18	.46	1.50	88.86			
19	.43	1.38	90.23			
20	.37	1.20	91.43			
21	.34	1.10	92.53			
22	.31	1.01	93.54			
23	.31	1.00	94.53			
24	.28	.91	95.44			
25	.26	.85	96.30			
26	.23	.74	97.04			
27	.21	.69	97.73			
28	.21	.69	98.42			
29	.19	.62	99.03			
30	.17	.56	99.58			
31	.13	.42	100.00			

Extraction Method: Principal Component Analysis.

Table 8: Harman's One-Factor Statistical Test Results

Standardized Regression Weights with CLF					Standardized Regression Weights without CLF					
Item	**Path Direction**	**Construct**	**Estimate**		**Item**	**Path Direction**	**Construct**	**Estimate**		**Delta**
TI2	←	TI	0.74		TI2	←	TI	0.74		0.00
TI3	←	TI	0.70		TI3	←	TI	0.70		0.00
TI5	←	TI	0.78		TI5	←	TI	0.79		0.01
TI4	←	TI	0.67		TI4	←	TI	0.68		0.01
TI8	←	TI	0.65		TI8	←	TI	0.65		0.00
TS2	←	TS	0.89		TS2	←	TS	0.91		0.02
TS1	←	TS	0.87		TS1	←	TS	0.88		0.01
TS3	←	TS	0.84		TS3	←	TS	0.86		0.02
TP1	←	TP	0.81		TP1	←	TP	0.83		0.02
TP2	←	TP	0.71		TP2	←	TP	0.73		0.02
TP3	←	TP	0.78		TP3	←	TP	0.80		0.02
TP4	←	TP	0.61		TP4	←	TP	0.63		0.02
TD2	←	TD	0.80		TD2	←	TD	0.80		0.00
TD1	←	TD	0.65		TD1	←	TD	0.66		0.01
TD4	←	TD	0.73		TD4	←	TD	0.74		0.01
SU5	←	SU	0.96		SU5	←	SU	0.96		0.00
SU6	←	SU	0.72		SU6	←	SU	0.73		0.01
SU2	←	SU	0.61		SU2	←	SU	0.63		0.02
AU5	←	AU	0.91		AU5	←	AU	0.91		0.00
AU6	←	AU	0.74		AU6	←	AU	0.75		0.01
AU2	←	AU	0.54		AU2	←	AU	0.55		0.01
FC2	←	FC	0.74		FC2	←	FC	0.76		0.02
FC1	←	FC	0.68		FC1	←	FC	0.69		0.01
FC3	←	FC	0.71		FC3	←	FC	0.72		0.01
TU2	←	TU	0.94		TU2	←	TU	0.95		0.01
TU1	←	TU	0.75		TU1	←	TU	0.76		0.01
TE3	←	TE	0.57		TE3	←	TE	0.58		0.01
TE2	←	TE	0.84		TE2	←	TE	0.86		0.02

Notes: TU = Task Uncertainty, TE = Task Equivocality, TI = Task Independence, TD = Task Differentiation, SU = Synchronous Collaboration Technology, AU = Asynchronous Collaboration Technology, TK = Task Knowledge Sharing, TS = Task Satisfaction, TP = Task Productivity, and FC = Fashion Consciousness

Table 9: Common Latent Factor Test Results

Lindell and Whitney's (2001) marker variable method was an additional test utilized in this study to gain more accurate representation of common-method bias. This test employed a

theoretically unrelated construct, called a marker variable, to adjust the correlations among the principal or focal constructs in the correlation matrix. Fashion consciousness, a variable in a motivation research study by Wells and Tigert (1971), was utilized as the marker variable, as it was theoretically unrelated to any of the other constructs in the current study. After adding the marker variable to the model with a CLF, the regression weight which reflected the correlation between the CLF and each measurement item was reduced from .12 to .11. This lower correlation among constructs in the model with a marker variable confirmed that common-method bias did not post a risk in the study.

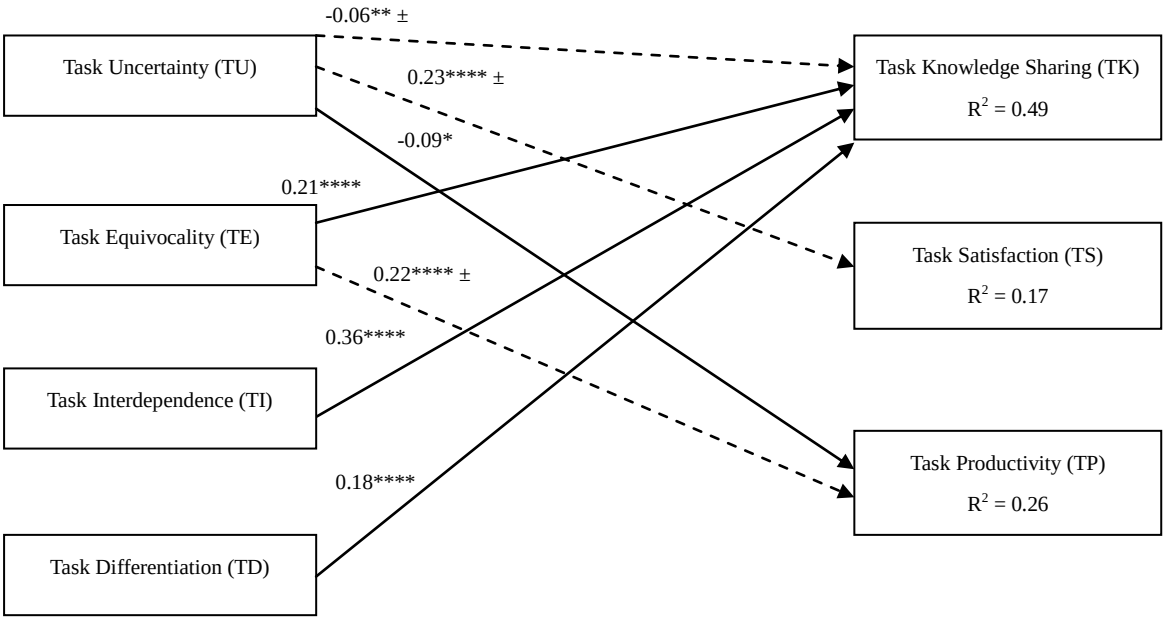
4.7 Hypotheses Testing

Due to the complexity of the research model with multiple interaction effects but a relatively small dataset of 161 respondents, separate analyses of the effects of synchronous and asynchronous collaboration technology usage was deemed appropriate. Doing so also simplified the data interpretation.

Before conducting the hypothesis testing, the latent factors in the CFA model were transformed into composite variables for use in the structural model through a linear regression data imputation method available in AMOS. A SPSS dataset with the newly created composite variables was used to create the independent variables, multiplicative interaction terms, and dependent variables to use in structural model. However, before the moderation testing in AMOS, the independent variables and moderators needed to be standardized to avoid multicollinearity. The standardized variables were calculated from the composite variables in SPSS. The newly created variables were prefixed with the letter Z

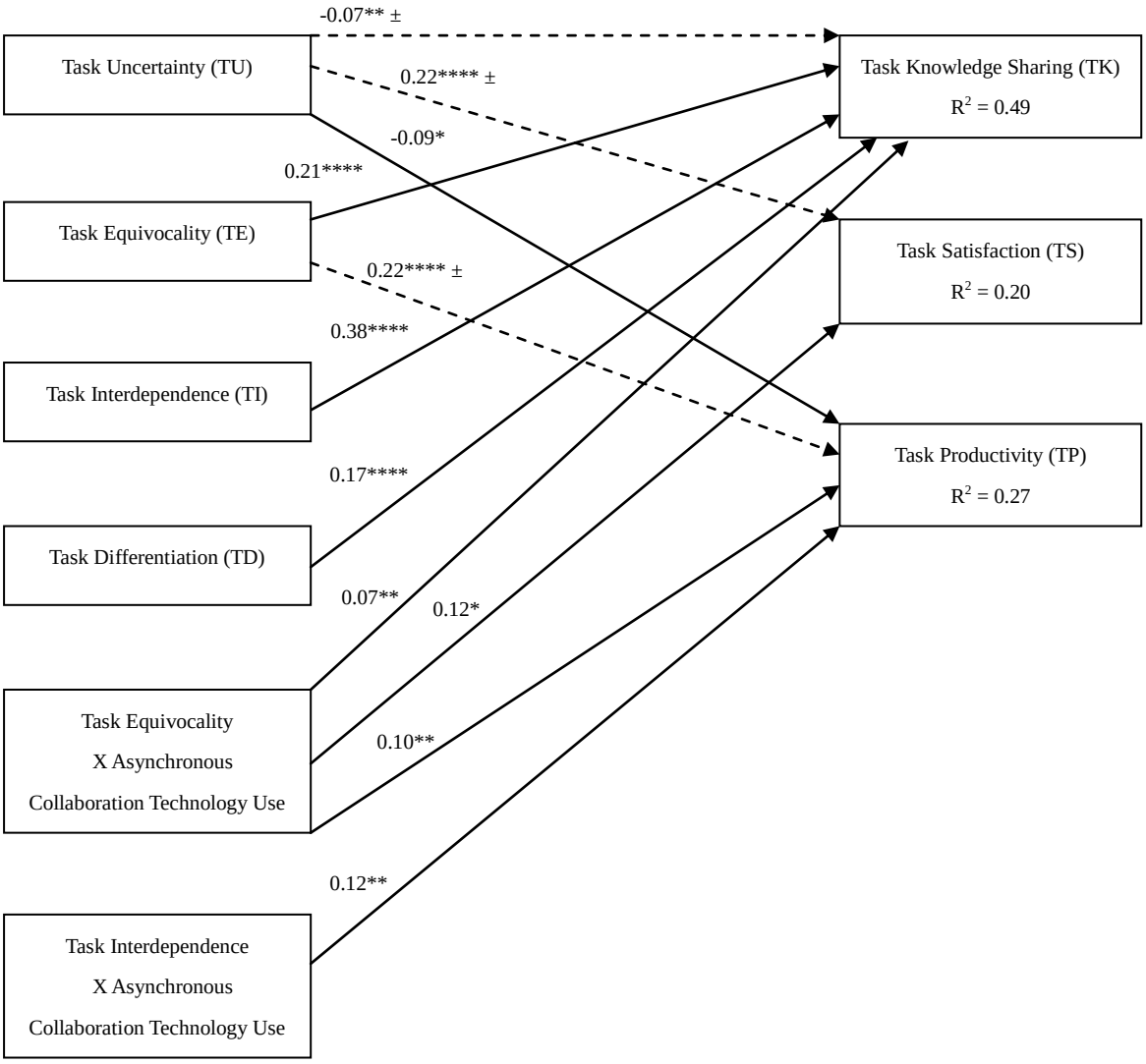
(e.g., ZTU for standardized task uncertainty) as shown in Tables 10a and b below. The product terms created from the standardized independent variables and standardized moderators were utilized to determine the interaction effects in the structural model.

To minimize confusion and promote easier understanding of the hypotheses tests, only the supported relationships are shown in Figures 2a and 2b, although all the test results are displayed in Tables 10a and 10b. The path values for usage of synchronous collaboration technologies are displayed in Table 10a, whereas the path values for usage of asynchronous collaboration technologies are displayed in Table 10b. The graphs of all moderation tests can be viewed in Appendix E. To assess the amount of variation accounted for by the independent variables and moderators, the magnitude of the R-square was calculated for the dependent variables and this ranged from 0.17 to 0.49.



Notes: **** p-value < 0.001; *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10
± = Reversed Effect

Figure 2a: Structural Model for Synchronous Collaboration Technology Use



Notes: **** p-value < 0.001; *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

± = Reversed Effect

Figure 2b: Structural Model for Asynchronous Collaboration Technology Use

DV	Path Direction	IV	Estimate	S.E.	C.R.	P
TK	←	ZTU	-0.06	0.03	-2.02	0.04
TS	←	ZTU	0.23	0.06	3.82	***
TP	←	ZTU	-0.09	0.05	-1.92	0.05
TK	←	ZTI	0.36	0.04	10.52	***
TS	←	ZTI	-0.08	0.07	-1.26	0.21
TP	←	ZTI	-0.02	0.05	-0.34	0.73
TK	←	ZTD	0.18	0.04	4.92	***
TS	←	ZTD	0.10	0.07	1.38	0.17
TP	←	ZTD	0.01	0.05	0.25	0.81
TK	←	ZTE	0.21	0.03	6.50	***
TS	←	ZTE	0.09	0.06	1.40	0.16
TP	←	ZTE	0.22	0.05	4.57	***
TK	←	TUxSU	0.01	0.03	0.29	0.78
TS	←	TUxSU	0.04	0.06	0.65	0.52
TP	←	TUxSU	-0.05	0.05	-0.92	0.36
TK	←	TIxSU	-0.00	0.04	-0.09	0.93
TS	←	TIxSU	-0.08	0.07	-1.12	0.26
TP	←	TIxSU	-0.01	0.06	-0.13	0.90
TK	←	TDxSU	0.02	0.04	0.97	0.33
TS	←	TDxSU	0.07	0.07	1.05	0.29
TP	←	TDxSU	0.06	0.05	1.22	0.22
TK	←	TExSU	0.02	0.03	0.46	0.65
TS	←	TExSU	0.05	0.06	0.77	0.45
TP	←	TExSU	0.05	0.05	1.13	0.26
TK	←	ZSU	0.08	0.03	3.09	0.00
TS	←	ZSU	0.06	0.05	1.26	0.21
TP	←	ZSU	0.12	0.02	3.01	0.00

Notes: TU = Task Uncertainty, TE = Task Equivocality, TI = Task Independence, TD = Task Differentiation, SU = Synchronous Collaboration Technology, AU = Asynchronous Collaboration Technology, TK = Task Knowledge Sharing, TS = Task Satisfaction, TP = Task Productivity

Table 10a: Hypothesis Testing Results for Synchronous Collaboration Technology Use

DV	Path direction	IV	Estimate	S.E.	C.R.	P
TK	←	ZTU	-0.07	0.03	-2.24	0.03
TS	←	ZTU	0.22	0.06	3.79	***
TP	←	ZTU	-0.09	0.05	-1.88	0.06
TK	←	ZTI	0.38	0.04	10.69	***
TS	←	ZTI	-0.09	0.07	-1.40	0.16
TP	←	ZTI	-0.04	0.05	-0.72	0.47
TK	←	ZTD	0.17	0.04	4.70	***
TS	←	ZTD	0.07	0.07	0.96	0.34
TP	←	ZTD	-0.01	0.05	-0.21	0.84
TK	←	ZTE	0.21	0.03	6.39	***
TS	←	ZTE	0.08	0.06	1.38	0.17
TP	←	ZTE	0.23	0.05	4.78	***
TK	←	TUxAU	0.05	0.03	1.39	0.17
TS	←	TUxAU	0.09	0.06	1.44	0.15
TP	←	TUxAU	-0.01	0.05	-0.15	0.88
TK	←	TIxAU	0.02	0.03	0.65	0.52
TS	←	TIxAU	0.09	0.06	1.44	0.15
TP	←	TIxAU	0.12	0.05	2.48	0.01
TK	←	TDxAU	0.04	0.04	1.04	0.30
TS	←	TDxAU	-0.03	0.07	-0.41	0.68
TP	←	TDxAU	-0.05	0.05	-1.02	0.31
TK	←	TExAU	0.07	0.04	1.93	0.05
TS	←	TExAU	0.12	0.07	1.72	0.09
TP	←	TExAU	0.10	0.05	1.93	0.05
TK	←	ZAU	0.05	0.03	1.72	0.09
TS	←	ZAU	0.01	0.05	0.17	0.87
TP	←	ZAU	0.01	0.04	0.25	0.80

Notes: TU = Task Uncertainty, TE = Task Equivocality, TI = Task Independence, TD = Task Differentiation, SU = Synchronous Collaboration Technology, AU = Asynchronous Collaboration Technology, TK = Task Knowledge Sharing, TS = Task Satisfaction, TP = Task Productivity

Table 10b: Hypothesis Testing Results for Asynchronous Collaboration Technology Use

4.7.1 Multi-Group Moderation Analysis

This dissertation hypothesized a significant differential in the moderation effects upon the dependent variables from the usage of synchronous versus asynchronous collaboration technologies. A multi-group moderation analysis was thus conducted in which the t-values of the path loadings were compared using the following formula (Bradley et al., 2006).

$$t = \frac{Pathsample1 - Pathsample2}{[\sqrt{\frac{(m-1)\text{^}2}{(m+n-2)} * S.E.sample1\text{^}2 + (\frac{(n-1)\text{^}2}{(m+n-2)} * S.E.sample2\text{^}2]} * [\sqrt{\frac{1}{m} + \frac{1}{n}}]}$$

Where:

sample1: Moderation effect of synchronous collaboration technologies usage

sample2: Moderation effect of asynchronous collaboration technologies usage

m = n: Number of cases in the dataset, i.e., 161

S.E.: Standard error of the path

Each computed t-value had (n + m - 2) degrees of freedom, i.e., df = 330. The last column of the P value together with its T value in the previous column for all interaction effect rows in Table 11 suggested that there were no significant differences between the indirect effects of task characteristics and different synchronicity of collaboration technology usage on task outcomes.

		Synchronous Technologies Usage			Asynchronous Technologies Usage			Multigroup Difference	
DV	**Path Direction**	**IV**	**Estimate**	**P**	**IV**	**Estimate**	**P**	**T**	**P**
TK	←	ZTU	-0.06	0.04	ZTU	-0.07	0.03	0.180	0.857
TS	←	ZTU	0.23	0.00	ZTU	0.22	0.00	0.036	0.971
TP	←	ZTU	-0.09	0.05	ZTU	-0.09	0.06	0.031	0.975
TK	←	ZTI	0.36	0.00	ZTI	0.38	0.00	0.340	0.734
TS	←	ZTI	-0.08	0.21	ZTI	-0.09	0.16	0.107	0.914
TP	←	ZTI	-0.02	0.73	ZTI	-0.04	0.47	0.275	0.783
TK	←	ZTD	0.18	0.00	ZTD	0.17	0.00	0.117	0.907
TS	←	ZTD	0.10	0.17	ZTD	0.07	0.34	0.298	0.766
TP	←	ZTD	0.01	0.81	ZTD	-0.01	0.84	0.315	0.753
TK	←	ZTE	0.21	0.00	ZTE	0.21	0.00	0.022	0.982
TS	←	ZTE	0.09	0.16	ZTE	0.08	0.17	0.012	0.991
TP	←	ZTE	0.22	0.00	ZTE	0.23	0.00	0.166	0.868
TK	←	TUxSU	0.01	0.78	TUxAU	0.05	0.17	0.795	0.427
TS	←	TUxSU	0.04	0.52	TUxAU	0.09	0.15	0.542	0.588
TP	←	TUxSU	-0.05	0.36	TUxAU	-0.01	0.88	0.562	0.575
TK	←	TIxSU	-0.00	0.93	TIxAU	0.02	0.52	0.485	0.628
TS	←	TIxSU	-0.08	0.26	TIxAU	0.09	0.15	1.796	0.073
TP	←	TIxSU	-0.01	0.90	TIxAU	0.12	0.01	1.722	0.086
TK	←	TDxSU	0.04	0.33	TDxAU	0.04	0.30	0.020	0.984
TS	←	TDxSU	0.07	0.29	TDxAU	-0.03	0.68	1.048	0.296
TP	←	TDxSU	0.07	0.22	TDxAU	-0.05	0.31	1.596	0.112
TK	←	TExSU	0.02	0.65	TExAU	0.07	0.05	1.145	0.253
TS	←	TExSU	0.05	0.45	TExAU	0.12	0.09	0.763	0.446
TP	←	TExSU	0.05	0.26	TExAU	0.10	0.05	0.673	0.501
TK	←	ZSU	0.08	0.00	ZAU	0.05	0.09	0.840	0.401
TS	←	ZSU	0.06	0.21	ZAU	0.01	0.87	0.744	0.457
TP	←	ZSU	0.12	0.00	ZAU	0.01	0.80	1.909	0.057

Notes: *** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10

Table 11: Multi-Group Moderation Results

4.7.2 Statistical Power

Assessing power is expected to be a routine part of establishing the statistical validity of an estimated model (Chin, 1998). Statistical power is a factor assessing the ability of the research model to detect a significant effect. The recommended level of the power of a SEM model is .80 (Chin et al., 1996). However, IS research has typically had small to medium effect sizes (0.35 approximately) (Baroudi & Orlikowski, 1989), based on the standard effect size values: small = 0.20, medium = 0.50, and large = 0.80.

In this study, the results of statistical power calculation demonstrated a medium to large effect size (0.78 for task knowledge sharing, and 0.99 respectively for task satisfaction and task productivity) for all relationships in the research model, given the observed probability level of 0.05, the number of predictors of each dependent variable (12 predictors from task uncertainty, task equivocality, task interdependence, task differentiation, task uncertainty x synchronous collaboration technology use, task uncertainty x asynchronous collaboration technology use, task equivocality x synchronous collaboration technology use, task equivocality x asynchronous collaboration technology use, task interdependence x synchronous collaboration technology use, task interdependence x asynchronous collaboration technology use, task differentiation x synchronous collaboration technology use, and task differentiation x asynchronous collaboration technology use), the observed R-squared value of each dependent variable, and the total number of valid cases used in the analysis (161). Hence, statistical power was deemed sufficient to detect the significant or insignificant effects of all independent and interaction variables to all dependent variables in the context of this study.

CHAPTER 5

DISCUSSION

5.1 Discussion on Hypothesis Testing Results

The results of the data analysis provided support for H1c, H3a, H5a, and H7a. However, the results of H1a, H1b, and H3c were in the opposite direction from expectation. Thus of the 12 primary (i.e., direct effect) hypotheses, 4 were supported and 3 were contradicted. Of the 12 moderation hypotheses, 4 were contradicted. i.e., the positive moderating effect due to usage of asynchronous collaboration technologies for teamwork was stronger than that of synchronous collaboration technologies usage in the relationships between task equivocality and task knowledge sharing, task equivocality and task satisfaction, and task equivocality and task productivity. Asynchronous technologies also had a stronger moderating effect in the relationship between task interdependence and task productivity. The summary of the hypotheses testing results is displayed in Table 12.

Hypothesis	Results from Synchronous Collaboration Technology Usage	Results from Asynchronous Collaboration Technology Usage
Hypothesis 1a*: The greater the uncertainty in a team member's task, the greater will be that member's task knowledge sharing.*	Contradicted ($p < 0.05$)	Contradicted ($p < 0.05$)
	Contradicted	
Hypothesis 1b*: The greater the uncertainty in a team member's task, the lower will be that member's task satisfaction.*	Contradicted ($p < 0.001$)	Contradicted ($p < 0.001$)
	Contradicted	
Hypothesis 1c*: The greater the uncertainty in a team member's task, the lower will be that member's task productivity.*	Weakly Supported ($p < 0.1$)	Weakly Supported ($p < 0.1$)
	Supported	
Hypothesis 2a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task uncertainty and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Insignificant moderation effect
	Not Supported	
Hypothesis 2b*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task uncertainty and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Insignificant moderation effect
	Not Supported	
Hypothesis 2c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task uncertainty and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Insignificant moderation effect
	Not Supported	
Hypothesis 3a: *The greater the equivocality in a team member's task, the greater will be that member's task knowledge sharing.*	Supported ($p < 0.001$)	Supported ($p < 0.001$)
	Supported	
Hypothesis 3b: *The greater the equivocality in a team member's task, the lower will be that member's task satisfaction.*	Not Supported	Not Supported
	Not supported	
Hypothesis 3c: *The greater the equivocality in a team member's task, the lower will be that member's task productivity.*	Contradicted ($p < 0.001$)	Contradicted ($p < 0.001$)
	Contradicted	
Hypothesis 4a: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Significant moderation effect ($p < .05$)
	Not Supported	

Hypothesis	Results from Synchronous Collaboration Technology Usage	Results from Asynchronous Collaboration Technology Usage
Hypothesis 4b: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Weak moderation effect ($p < .10$)
	Weakly Contradicted	
Hypothesis 4c: *Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task equivocality and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Significant moderation effect ($p < .05$)
	Not Supported	
Hypothesis 5a*: The greater the interdependence in a team member's task, the greater will be that member's task knowledge sharing.*	Supported ($p < 0.001$)	Supported ($p < 0.001$)
	Supported	
Hypothesis 5b*: The greater the interdependence in a team member's task, the lower will be that member's task satisfaction.*	Not Supported	Not Supported
	Not supported	
Hypothesis 5c*: The greater the interdependence in a team member's task, the lower will be that member's task productivity.*	Not Supported	Not Supported
	Not supported	
Hypothesis 6a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Insignificant moderation effect
	Not Supported	
Hypothesis 6b*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Insignificant moderation effect
	Not Supported	
Hypothesis 6c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task interdependence and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Significant moderation effect ($p < .05$)
	Contradicted	
Hypothesis 7a*: The greater the differentiation in a team member's task, the greater will be that member's task knowledge sharing.*	Supported ($p < 0.001$)	Supported ($p < 0.001$)
	Supported	

Hypothesis	Results from Synchronous Collaboration Technology Usage	Results from Asynchronous Collaboration Technology Usage
Hypothesis 7b*: The greater the differentiation in a team member's task, the lower will be that member's task satisfaction.*	Not Supported	Not Supported
	Not supported	
Hypothesis 7c*: The greater the differentiation in a team member's task, the lower will be that member's task productivity.*	Not Supported	Not Supported
	Not supported	
Hypothesis 8a*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task knowledge sharing to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Insignificant moderation effect
	Not Supported	
Hypothesis 8b*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task satisfaction to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Insignificant moderation effect
	Not Supported	
Hypothesis 8c*: Use of synchronous collaboration technologies to work with other team members will moderate the relationship between task differentiation and task productivity to a greater positive extent than the use of asynchronous collaboration technologies.*	Insignificant moderation effect	Insignificant moderation effect
	Not Supported	

Table 12: Hypothesis Testing Results

The support for H1c, i.e., greater task uncertainty leads to lower task productivity, suggests that non-routine, random, unstable, and unpredictable tasks detrimentally impact the amount and quality of completed project work. To accommodate changes caused by such uncertain events, task completion deadlines might also need to be extended, raising concerns about the possibility of a runaway project.

The support for H3a informs us that team members do tend to share more knowledge when they have to deal with equivocal, ad-hoc and ill-defined problems at work or fluctuations in information available to perform their task. Such situations might lead them to have ambiguity or conflicting interpretations about the task at hand. To overcome such challenges, these members likely share knowledge about resource allocations, task schedules, task priorities, successes and failures, and feel comfortable seeking each other's help.

The support for H5a suggests that greater task interdependence, i.e., being dependent on other team members for accurate information and outputs in order to perform the assigned project work, spurs greater knowledge sharing. Being able to contact other team members when needed in order to seek solutions and help can enable a team member to perform his or her work correctly.

The support for H7a indicates that when team tasks are differentiated, or broken down into smaller sub-tasks within the project's overall work process, the team's members tend to exchange more knowledge. Greater sharing of problems, solutions, successes and failures are likely necessitated to coordinate the sub-tasks so to arrive at a successful conclusion for the project. Sharing sub-task experiences and helping other team members will help the team realize synergies from task differentiation.

The contradiction in H1a, i.e., greater task uncertainty causing lower knowledge sharing, might be understood from a social status and power perspective. Project team members confronted with uncertain tasks that they do not fully understand might be hesitant to discuss their lack of understanding with other team members for fear of ridicule or of being reassigned to a less prestigious task rather than a task of import for the team. Perhaps they might perceive the problem itself to be so hazy that they would have difficulty explaining to the team the solutions they are seeking. Confronted with such concerns, it is quite likely that such a team member might hunker down and try to solve the problem by himself or herself rather than seek knowledge and help from the team.

The contradiction found for H1b, i.e., greater task uncertainty causing greater task satisfaction implies that team members gain satisfaction by completing tasks that cannot be anticipated or predicted. They might prefer such challenging assignments to prevent boredom and stagnation that can occur from performing the same tasks over time. Perhaps the drive for proving oneself as being capable of rising to the challenge provides such a team member satisfaction and a sense of accomplishment.

The contradiction found for H3c, i.e., greater task equivocality leads to greater task productivity suggests that team members are likely to put extra effort into trial and error to make sufficient progress related to their ill-defined and seemingly intransigent task rather than be at a standstill. Their sense of accomplishment in terms of work quality and ability to stick to deadlines is no doubt embellished by making steady progress on equivocal tasks.

Lack of support for several hypotheses related to task satisfaction and task productivity (i.e., H3b, H5b, H7b, H5c, and H7c) may be due to the characteristics of the subject group. A

majority of the survey respondents were highly educated, aged between 30-50, with almost 10 years tenure in their current job. These demographics imply that for these employees characteristics such as task equivocality, interdependence, or differentiation do not significantly impact their task satisfaction and productivity. Most likely, they have experience working on multiple projects in their careers and their team members are likely to be colleagues they are familiar with.

Lack of support for the interaction hypotheses (i.e., H2a-c, H6a-b, and H8a-c) informs us that team members do not perceive improvement in their task knowledge sharing, satisfaction, and productivity when they use synchronous collaboration technologies in preference to asynchronous collaboration technologies. This implies that team members probably choose whichever collaboration tools are readily available to them in the organization without the consideration of specific benefits derived from synchronicity of the media or its fit to different types of tasks.

However, there were other interesting findings related to H4a-c, and H6c. These represented four moderating relationships between task characteristics and outcomes resulting from usage of asynchronous collaboration technologies.

1. Asynchronous collaboration technology usage significantly moderated the relationship between task equivocality and task knowledge sharing, i.e., greater use of asynchronous collaboration technologies to work with other team members enhances the team member's knowledge sharing about his or her equivocal task.
2. Asynchronous collaboration technology usage significantly moderated the relationship between task equivocality and task satisfaction, i.e., greater use of

asynchronous collaboration technologies to work with other team members enhances the team member's satisfaction with his or her equivocal task.

3. Asynchronous collaboration technology usage significantly moderated the relationship between task equivocality and task productivity, i.e., greater use of asynchronous collaboration technologies to work with other team members enhances the team member's productivity on his or her equivocal task.

4. Asynchronous collaboration technology usage significantly moderated the relationship between task interdependence and task productivity, i.e., greater use of asynchronous collaboration technologies to work with other team members enhances the team member's productivity on his or her interdependent task.

Interestingly, these findings suggest that by using asynchronous collaboration technologies that are more effective for processing simple messages and standard data rather than complex and subjective messages in the communication within a dispersed team, team members' knowledge sharing, satisfaction, and productivity are improved when they are dealing with equivocal tasks, i.e., tasks that are ill-defined, ad-hoc, and non-routine.

While the direct effect of task interdependence on task productivity was not found to be significant, asynchronous collaboration technology usage did significantly improve task productivity for interdependent project tasks.

These relationships among task characteristics, collaboration technology use, and task outcomes only partially confirms the premise of media richness theory that the less ambiguous a task is, the leaner the media that suits it. Leaner communication means are generally more effective for communication in the case of expected or clear issues than richer

media. However, this dissertation did not find that richer communication as embodied in synchronous collaboration technologies improved task outcomes for uncertain, equivocal, interdependent or differentiated tasks. Rather it found that the leaner asynchronous technologies seemed better at supporting equivocal and interdependent tasks. Perhaps the value inherent in synchronous communication technologies is over-hyped or perhaps synchronous technology-enabled meetings are no different from their physical counterparts wherein much is said but little actually accomplished.

5.2 Implications for Researchers

Media richness theory was originally developed to evaluate communication media in organizations. The premise of the theory is that the more uncertain and ambiguous a task is, the richer the media that suits it. In other words, richer communication means are generally more effective for communication of unexpected or equivocal issues rather than leaner media.

This study applied the theory to understand the behavior of project team members in using collaboration technologies to perform their project tasks and to affect their task outcomes. The results of the unsupported interaction hypotheses (i.e., H2a-c, H6a-b, and H8a-c) indicate that employees do not always choose the mode of communication based on matching task characteristics and outcomes to the medium. Other factors such as the resource availability might come into play. Employees might refrain from using the collaborating tool that repeatedly loses audio, pictures, messages, or connectivity. In addition, the group norm or culture might have a strong influence on the media usage or choice, as suggested by prior researchers (Kraut et al., 1998). Therefore, future research is needed to evaluate the

assumptions in media richness theory regarding task characteristics and the likelihood of using a medium over others based on the media richness.

Another plausible reason to explain why the findings failed to support most interaction hypotheses is that the surveyed collaboration tools failed to differ in terms of synchronicity. The respondents were asked to differentiate the types of the tools based on their own perception. Therefore, the richness degree of the selected tools for some respondents might be minimal. Furthermore, the respondents were allowed to aggregate a group of tools to define synchronous versus asynchronous collaboration tools. The varied richness degrees of each tool could prevent the respondents to appropriately justify their usage on each type of collaboration technologies. The technology usage measures thus became not sensitive enough to detect differences.

While the differential usage of synchronous versus asynchronous collaboration technologies did not obviously impact the relationship between task characteristics and task outcomes, the usage of asynchronous communication technologies was found to be significantly related to task equivocality and its relationship with knowledge sharing, satisfaction, and productivity in H4a-c. It was also found to influence the relationship between task interdependence and task productivity in H6c. On the other hand, the usage of synchronous communication technologies did not significantly impact the relationships between task characteristics and outcomes in H2a-c, H4a-c, H6a-c, and H8a-c. These findings indicated that task knowledge sharing, satisfaction, and productivity were improved when lean media were employed with ambiguous and interdependent tasks. Such findings are consistent with the study of Dennis and Kinney (1998), wherein they investigated the usage of

contemporary media with multiple cues and immediacy of feedback and found that these rich media did not improve performance on highly equivocal tasks. They claimed that matching richness to task equivocality did not improve performance. While the current study utilized the perspective of "fit" between task characteristics and communication media in terms of moderating effects of technology synchronicity, perhaps different results may result by examining mediating effects of communication synchronicity.

5.3 Implications for Practitioners

The opposite results of H1b imply that employees are satisfied when they are given task assignments that challenge them. Managers should allow their employees to explore new or different tasks from their day-to-day responsibilities. This helps employees be more satisfied in performing the task and improve their productivity as inferred from the results of H1c. Highly equivocal tasks also motivate them to be more productive, according to the opposite results of H3c. However, managers should provide their employees thorough guidance, mentoring, or training when they have to explore an unknown task. This helps employees gain greater confidence to perform the task, and be willing to exchange knowledge and experiences with their project teams. The opposite results of H1a imply that employees who have no confidence to perform the task tend to share less knowledge.

The results of H5a and H7a suggest that employees who depend on other team members to perform a task or employees whose tasks are broken down into smaller sub-tasks within the project's overall work process tend to share more knowledge. Increased usage of asynchronous collaboration technologies with equivocal and interdependent tasks enhances

task knowledge sharing, satisfaction, and productivity, based on the contradicted results of H4a-c and H6c. For tasks that are interdependent and differentiated, employees should perhaps spend more time and effort in crafting a message or document before sharing it with their team members. Managers can empower their employees to take actions or make good decisions by fostering open communication within the team through asynchronous collaboration tools.

The results of the study imply that employees are willing to learn or share the task knowledge or opinions with other team members in order to strengthen their ability to perform their tasks. An employee who clearly understands the purpose, direction, and value of the project and the role of each team member can take appropriate action and easily make decisions. As collaboration continues globally thanks to cloud computing, mobile technology innovations, and Internet connectivity, organizations should increasingly seek emerging tools to ensure that their employees can effectively and efficiently communicate, track project statuses, and exchange information to solve their problems.

5.4 Limitations and Future Research

Many relationships in the designed research model were found insignificant. Future study in this domain may need to limit choices of collaboration technologies to completely control the degree of synchronicity of the tools. Even though, a field study methodology can provide generalizability, in the current study the responses to the collaboration technology usage were aggregated from all tools used. Some tools might be utilized much more or less than others. Their degrees of synchronicity might also be different. In some other occasions, tools such as

e-mail might be considered as extremely asynchronous collaboration technologies for some users or fairly asynchronous collaboration technologies for other users. The differentiation between technology synchronicity for some respondents might be weak.

In addition, some factors such as resource availability and cultural bias in choosing the media choice in team collaboration were not controlled in this study. This might lessen the utility or generalizability of findings in this study. The results of this study should thus be cautiously interpreted. Future research can utilize a laboratory study, instead of a survey methodology which has inherent limitations in manipulation of independent variables, to manipulate task uncertainty, equivocality, interdependence, and differentiation as well as choice of communication media. The current study provides valuable information on which tools are most frequently used by project teams for their tasks. If future research limits media choices to certain specified ones, the synchronicity of the provided tools can be more obvious and the group norm may not govern the usage.

Future study might also consider extending the scope of the current study by including the differential usage of synchronous versus asynchronous collaboration technologies as dependent variables of the task characteristics or outcomes. Perhaps different results will be found by examining mediating effects of communication synchronicity.

In addition, the current study has not clarified how and why collaboration tools were chosen and how and why the task characteristics, synchronous and asynchronous collaboration technology usage, and task outcomes are related to each other. Future research can utilize the qualitative research methodology to answer these questions.

The current study only provided a one-time snapshot of employee experience. It included

both on-going and completed projects. Moreover, the on-going projects were allowed to be at any stage of completion from the beginning until close to the end of the project. The benefit of this cross-sectional study allowed us to compare many different variables from all kinds of team projects at the same time. However, the study did not consider other impacts that might occur before or after the taken snapshot. Thus, we cannot know for sure that once team members become more familiar with their project tasks or with other team members as the project moves along, whether their collaboration technology usage may switch from synchronous to asynchronous as the task becomes less uncertain, equivocal, or interdependent. Future research can be conducted at the different phases of an assigned project to see any significant changes in media use. A longitudinal study may provide a new insight to how the media usage or task perceptions can change over time as employees adjust to the project environment and other team members.

Lastly, bias from the self-reported measures, especially perceived-performance measures, might not be easy to entirely avoid. While several methods, including Harman's one-factor statistical test, common latent factor analysis, and marker variable method, conducted in this study rule out this bias, these methods are not failsafe.

CHAPTER 6

CONCLUSION

This dissertation examined the influence of an individual team member's task characteristics on task outcomes in the context of differential usage of synchronous versus asynchronous collaboration technologies so as to bridge the gap between real world practice and research literature on collaboration technologies. Several assumptions were drawn from media richness theory to predict, explain, and understand the impacts of a project team member's task characteristics and extent of usage of contemporary collaboration technologies on the member's task outcomes. A cross-sectional research design with a quantitative empirical approach by using a survey questionnaire was conducted to collect data from project team members who employed at least one synchronous and one asynchronous collaboration technology in their communication with the team members.

The results from data analysis demonstrated the value of the research model by providing the understanding that a project team member's task uncertainty, equivocality, and interdependence are associated with task knowledge sharing, satisfaction, and productivity. However, the differential usage of synchronous versus asynchronous collaboration technologies does not significantly impact the relationships between the team member's task characteristics and task outcomes.

Researchers still need to further examine the synchronicity of communication as a significant characteristic on collaboration technologies to completely understand how the tools can be effectively used by the project team members. Nevertheless, managers can learn

from this study that their employees readily communicate with each other and exchange information to solve their project problems through collaboration tools. Therefore, managers should continue to provide such resources to meet their collaboration needs. In the end, this study broadens our understanding of the utility of synchronous and asynchronous collaboration technologies for teamwork.

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APPENDIX A

CONSENT FORM

Same-Time and Different-Time Collaboration Technology Use in Teamwork

You are invited to participate in a study to understand the relationships between collaboration technology and organization performance. The results may be of value to your organization in understanding its current use of the technologies and planning its future use of them. For your response, $1 will be contributed to United Way of Greater St. Louis. Your participation is voluntary and anonymous, and I deeply appreciate it.

If you have any questions or concerns about your rights as a research subject, please contact the Chairperson of the Institutional Review Board of the University of Missouri – St. Louis at (314) 516-5897. Please ask the principal investigator any other questions at (314) 680-7995 or sundaravejf@umsl.edu.

Thank you.

Thanaporn Sundaravej

Principal Investigator

Doctoral Candidate

College of Business Administration

University of Missouri at Saint Louis

I acknowledge that I have read this invitation and agree to participate in the research described above.

Signature of Participant	Date

APPENDIX B

SURVEY QUESTIONNAIRE

Questionnaire Instructions

This questionnaire examines team collaboration using information technologies (IT). It will take about 10 minutes to complete.

Same-time (also called synchronous) IT-based collaboration tools enable immediate communication to support cooperation among individuals on a common project. Examples typically include video/web/audio conferencing and instant messaging.

Different-time (also called asynchronous) IT-based collaboration tools enable delayed communication to support cooperation among individuals on a common project. Examples typically include e-mail, fax, discussion boards, wikis, blogs, social networks, and Twitter.

In the questions on the following pages, please focus on your main role in the most recent project where your team uses or used at least one same-time and one different-time collaboration tool.

Some tools enable both same-time and different-time communication.

- Please consider a tool with more immediate communication usage as same-time.
- Please consider a tool with more delayed communication usage as different-time.

If the usage for immediate and delayed communication is about equal, please consider a different tool.

Survey Questions

Have you recently participated on a team project using at least one same-time and one different-time collaboration tool?

__ Yes __ No

Describe your main role on the project.

_____

_____

Please provide the number of members on the project team. _____

Please provide the duration of the project. _____

Is the project completed or on-going?

__ Completed__ On-Going

Which same-time collaboration tool(s) does (did) your team use for the selected project?

Check all that apply.

- **Audio Conferencing**: simultaneous interaction via voice among multiple parties
- **Video Conferencing**: simultaneous interaction via both voice and video (e.g. Cisco TelePresence)

- **Web Conferencing**: simultaneous interaction via voice, video, and file sharing using any computer (e.g. Adobe Connect, AT&T Connect, Cisco WebEx Meeting Center, GoToMeeting, IBM LotusLive Meeting, Microsoft Lync Online, Microsoft Office Live Meeting, Skype, Google Talk, or Google+ Hangouts)
- **Instant Messaging**: simultaneous interaction using text (e.g. Google Talk, Skype, IBM Lotus Sametime, or Microsoft Instant Messanger, or any other SMS text messaging)
- **Telephone**: simultaneous interaction via voice between two parties
- If other, please specify: _____

How would you rate your overall ability with the same-time tool(s) in collaborating with your team for the selected project?

Poor Fair Average Good Excellent

Which different-time collaboration tool(s) does (did) your team use for the selected project? Check all that apply.

- **E-Mail**
- **Fax**
- **Discussion Board**: an online forum where ideas and information of a particular topic can be exchanged through a web browser
- **Wiki**: a website that allows collaborative editing of its content and structure by its users

- **Blog**: a personal website on which an individual shares entries displayed in reverse-chronological order
- **Social Network**: a website that enables users to communicate with each other by posting information, comments, messages, images, etc. (e.g., Facebook)
- **Microblog**: a website that enables its users to send and read other users' messages (e.g., Twitter)
- If other, please specify: _____

How would you rate your overall ability with the different-time tool(s) in collaborating with your team for the selected project?

Poor Fair Average Good Excellent

In performing your work on the project, to what extent do you agree or disagree with the following statements?

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neither Agree Nor Disagree**	**Agree**	**Strongly Agree**

1. My work is (was) quite routine. 1 2 3 4 5
2. My work is (was) quite repetitive. 1 2 3 4 5
3. My work is (was) quite stable. 1 2 3 4 5
4. My work is (was) quite predictable. 1 2 3 4 5
5. I deal (dealt) with ill-defined business problems for my work. 1 2 3 4 5
6. I deal (dealt) with ad-hoc, non-routine business problems for my work. 1 2 3 4 5

7. My work involves (involved) answering questions that I have (had) never been asked before. 1 2 3 4 5

8. I have (had) to communicate with my team members to get my work done. 1 2 3 4 5

9. I can (could) perform my work fairly independently of my team members. 1 2 3 4 5

10. I can (could) plan my work with little need to coordinate with other team members. 1 2 3 4 5

11. I am (was) rarely required to obtain information from other team members to complete my work. 1 2 3 4 5

12. My work is (was) relatively unaffected by the performance of other individuals in the team. 1 2 3 4 5

13. My work requires (required) frequent coordination with the efforts of other individuals in the team. 1 2 3 4 5

14. My work performance depends (depended) on receiving accurate information from other team members…….. 1 2 3 4 5

15. I work (worked) independently of other team members to accomplish the assigned work……..…….. 1 2 3 4 5

16. I meet (met) with other team members to discuss how my work should be performed or treated. 1 2 3 4 5

17. I have (had) a small number of tasks to perform in my work. 1 2 3 4 5

18. My work is (was) largely uncomplicated. 1 2 3 4 5

19. My work constitutes (constituted) a small part of the overall work process of the team. 1 2 3 4 5

20. My work is (was) largely unvaried. 1 2 3 4 5

21. I discuss (discussed) problems and solutions related to my work with other team members. 1 2 3 4 5

22. I can (could) easily contact other team members about my work when needed. 1 2 3 4 5

23. I share (shared) success and failure experiences related to my work with other team members. 1 2 3 4 5

24. I get (got) solutions to my work problems from other team members. 1 2 3 4 5

25. I feel (felt) comfortable in seeking help related to my work from other team members. 1 2 3 4 5

26. Generally speaking, I feel (felt) satisfied with my work. 1 2 3 4 5

27. Overall, I feel (felt) satisfied with the kind of work I do in this project. 1 2 3 4 5

28. In general, I feel (felt) satisfied with the work assigned to me. 1 2 3 4 5

29. I rate the amount of work I complete (completed) as being outstanding. ……..... 1 2 3 4 5

30. I rate the amount of time it takes (took) me to complete my assigned work as being outstanding. 1 2 3 4 5

31. I rate the quality of my work as being outstanding. 1 2 3 4 5

32. I rate my record of completing work on time (i.e., not being late in meeting assigned deadlines) as being outstanding. 1 2 3 4 5

33. When I must choose between the two, I usually dress for fashion, not for comfort. 1 2 3 4 5

34. An important part of my life and activities is dressing smartly. 1 2 3 4 5

35. A person should try to dress in style. ……..... 1 2 3 4 5

In performing your work on the project, please describe the extent of your use of <u>same-time</u> collaboration tools.

1	2	3	4	5
Never	**Seldom**	**Occasionally**	**Frequently**	**Almost Always**

1. To discuss work-related subjects with other team members. .....….. 1 2 3 4 5

2. To discuss idea with other team members. ……..……..... 1 2 3 4 5

3. To discuss procedures with other team members. ……..……..... 1 2 3 4 5

4. To discuss policies with other team members. ……..……..……..... 1 2 3 4 5

5. To arrange schedules with other team members. ……...……..……..... 1 2 3 4 5

6. To share information with other team members. ……...……..…….... 1 2 3 4 5

7. To find solutions for difficult team problems. ……..…….... 1 2 3 4 5

8. To solve sensitive issues in my team. ……..……..…….... 1 2 3 4 5

In performing your work on the project, please describe the extent of your use of <u>different-time</u> collaboration tools.

1	2	3	4	5
Never	**Seldom**	**Occasionally**	**Frequently**	**Almost Always**

1. To discuss work-related subjects with other team members. 1 2 3 4 5

2. To discuss idea with other team members. 1 2 3 4 5

3. To discuss procedures with other team members. 1 2 3 4 5

4. To discuss policies with other team members. 1 2 3 4 5

5. To arrange schedules with other team members. 1 2 3 4 5

6. To share information with other team members. 1 2 3 4 5

7. To find solutions for difficult team problems. 1 2 3 4 5

8. To solve sensitive issues in my team. 1 2 3 4 5

In performing your work on the project, please indicate the percent of team collaboration time using same-time versus different-time collaboration tools. Total should be 100%.

____ % Same-Time Tools ____ % Different-Time Tools

Demographic Questions

Which departments collaborated on this particular project?

- Accounting
- Finance

- Human Resources
- Information Systems
- Production
- R & D
- Sales
- If other, please specify: _____

What is your job title? _____

How many years have you worked for the company? _____

Please indicate your age group.

Under 30 30-39 40-49 50-59 60 and over

Please indicate your gender.

Female Male

Please indicate your completed level of education.

- Diploma or Less
- Associate Degree (2 Years)
- Undergraduate Degree
- Masters Degree

- Doctoral Degree
- If other, please specify: _____

If you have any comments about this survey, please feel free to write them here.

_____

_____

----------End of the Survey----------

We thank you for your time spent taking this survey. Your response has been recorded.

If you would like a summary of the results of the survey, please send a separate e-mail request to sundaravejf@umsl.edu.

APPENDIX C

DESCRIPTIVE STATISTICS

Item	N	Min	Max	Mean	S.D.
TU1: My work is (was) quite routine.	161	1	5	2.47	1.031
TU2: My work is (was) quite repetitive.	161	1	5	2.41	.939
TE2: I deal (dealt) with ad-hoc, non-routine business problems for my work.	161	1	5	3.84	.843
TE3: My work involves (involved) answering questions that I have (had) never been asked before.	161	2	5	3.82	.749
TI2: I can (could) perform my work fairly independently of my team members.	161	1	5	2.84	1.259
TI3: I can (could) plan my work with little need to coordinate with other team members.	161	1	5	2.47	1.168
TI4: I am (was) rarely required to obtain information from other team members to complete my work.	161	1	5	2.21	1.126
TI5: My work is (was) relatively unaffected by the performance of other individuals in the team.	161	1	5	2.19	1.016
TI8: I work (worked) independently of other team members to accomplish the assigned work.	161	1	5	2.75	1.136
TD1: I have (had) a small number of tasks to perform in my work.	161	1	5	2.18	.935
TD2: My work is (was) largely uncomplicated.	161	1	5	2.17	.939
TD4: My work is (was) largely unvaried.	161	1	5	2.29	.904
SU2: I use (used) same-time collaboration tools to discuss ideas with other team members.	161	1	5	3.77	.896
SU5: I use (used) same-time collaboration tools to arrange schedules with other team members.	161	1	5	3.48	1.019
SU6: I use (used) same-time collaboration tools to share information with other team members.	161	1	5	3.14	1.148
AU2: I use (used) different-time collaboration tools to discuss ideas with other team members.	161	1	5	3.71	.899
AU5: I use (used) different-time collaboration tools to arrange schedules with other team members.	161	1	5	3.51	1.055
AU6: I use (used) different-time collaboration tools to share information with other team members.	161	1	5	3.50	1.130
TK3: I share (shared) success and failure experiences related to my work with other team members.	161	2	5	4.03	.720
TK4: I get (got) solutions to my work problems from other team members.	161	1	5	3.81	.838
TK5: I feel (felt) comfortable in seeking help related	161	2	5	4.08	.750

to my work from other team members.					
TS1: Generally speaking, I feel (felt) satisfied with my work.	161	2	5	4.03	.762
TS2: Overall, I feel (felt) satisfied with the kind of work I do in this project.	161	2	5	4.06	.673
TS3: In general, I feel (felt) satisfied with the work assigned to me.	161	2	5	3.97	.720
TP1: I rate the amount of work I complete (completed) as being outstanding.	161	2	5	3.75	.689
TP2: I rate the amount of time it takes (took) me to complete my assigned work as being outstanding.	161	1	5	3.53	.799
TP3: I rate the quality of my work as being outstanding.	161	2	5	3.84	.688
TP4: I rate my record of completing work on time (i.e., not being late in meeting assigned deadlines) as being outstanding.	161	2	5	3.84	.795
FC1: When I must choose between the two, I usually dress for fashion, not for comfort.	161	1	5	2.70	1.096
FC2: An important part of my life and activities is dressing smartly.	161	1	5	3.37	.933
FC3: A person should try to dress in style.	161	1	5	3.44	.813

APPENDIX D

MODEL FIT SUMMARY

Model Fit during the Confirmatory Factor Analysis (CFA)

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	107	493.523	389	.000	1.269
Saturated model	496	.000	0		
Independence model	31	2496.781	465	.000	5.369

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.049	.841	.797	.659
Saturated model	.000	1.000		
Independence model	.185	.414	.375	.388

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.802	.764	.950	.939	.949
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.837	.671	.794
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	104.523	51.679	165.513
Saturated model	.000	.000	.000
Independence model	2031.781	1878.920	2192.095

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	3.085	.653	.323	1.034
Saturated model	.000	.000	.000	.000
Independence model	15.605	12.699	11.743	13.701

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.041	.029	.052	.917
Independence model	.165	.159	.172	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	707.523	761.023	1037.234	1144.234
Saturated model	992.000	1240.000	2520.377	3016.377
Independence model	2558.781	2574.281	2654.304	2685.304

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	4.422	4.092	4.803	4.756
Saturated model	6.200	6.200	6.200	7.750
Independence model	15.992	15.037	16.994	16.089

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	142	149
Independence model	34	35

Model Fit in the Structural Model of Synchronous Collaboration Technology Use

Interactions

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	76	2.666	2	.264	1.333
Saturated model	78	.000	0		
Independence model	12	894.550	66	.000	13.554

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.026	.997	.890	.026
Saturated model	.000	1.000		
Independence model	.206	.578	.502	.489

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.997	.902	.999	.973	.999
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.030	.030	.030
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	.666	.000	9.290
Saturated model	.000	.000	.000
Independence model	828.550	735.667	928.863

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	.017	.004	.000	.058
Saturated model	.000	.000	.000	.000
Independence model	5.591	5.178	4.598	5.805

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.046	.000	.170	.395
Independence model	.280	.264	.297	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	154.666	168.108	388.852	464.852
Saturated model	156.000	169.796	396.350	474.350
Independence model	918.550	920.672	955.527	967.527

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	.967	.963	1.021	1.051
Saturated model	.975	.975	.975	1.061
Independence model	5.741	5.160	6.368	5.754

HOELTER

Model	HOELTER .05	HOELTER .01
Default model	360	553
Independence model	16	18

Model Fit in the Structural Model of Asynchronous Collaboration Technology Use

Interactions

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	77	1.140	1	.286	1.140
Saturated model	78	.000	0		
Independence model	12	870.405	66	.000	13.188

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.016	.999	.908	.013
Saturated model	.000	1.000		
Independence model	.198	.579	.503	.490

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.999	.914	1.000	.988	1.000
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.015	.015	.015
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	.140	.000	7.355
Saturated model	.000	.000	.000
Independence model	804.405	712.883	903.356

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	.007	.001	.000	.046
Saturated model	.000	.000	.000	.000
Independence model	5.440	5.028	4.456	5.646

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.030	.000	.214	.376
Independence model	.276	.260	.292	.000

AIC

Model	AIC	BCC	BIC	CAIC
Default model	155.140	168.759	392.408	469.408
Saturated model	156.000	169.796	396.350	474.350
Independence model	894.405	896.528	931.382	943.382

ECVI

Model	ECVI	LO 90	HI 90	MECVI
Default model	.970	.969	1.015	1.055
Saturated model	.975	.975	.975	1.061
Independence model	5.590	5.018	6.208	5.603

HOELTER

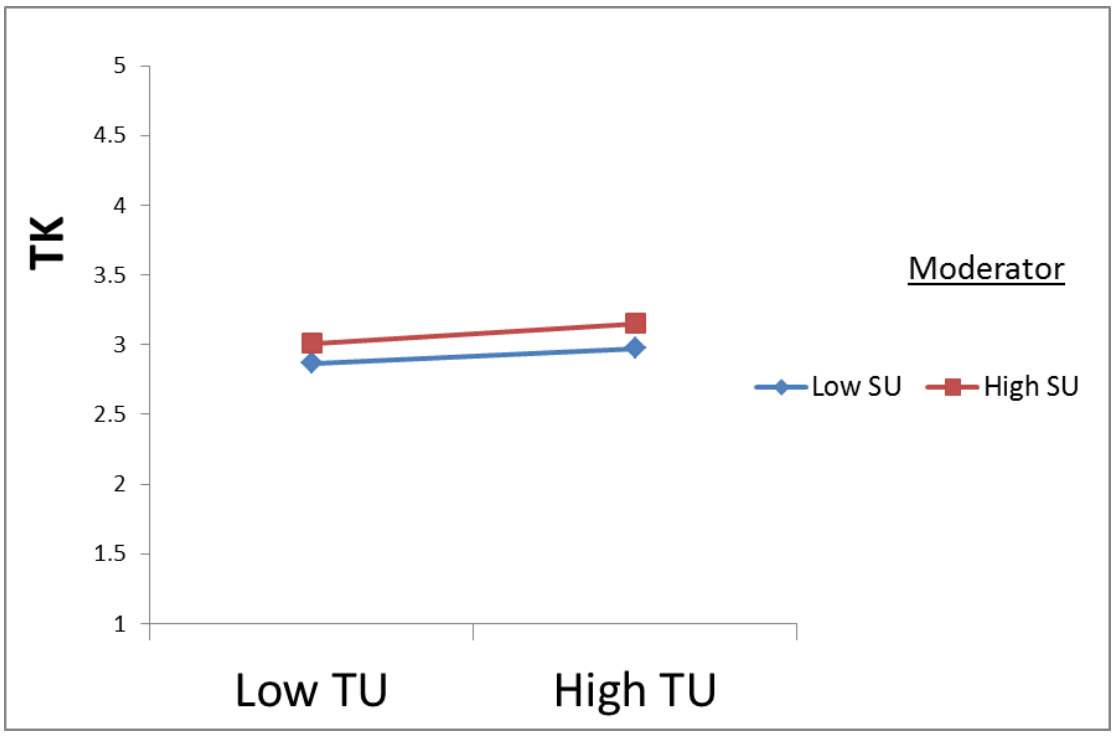
Model	HOELTER .05	HOELTER .01
Default model	539	931
Independence model	16	18

APPENDIX E

MODERATING EFFECTS

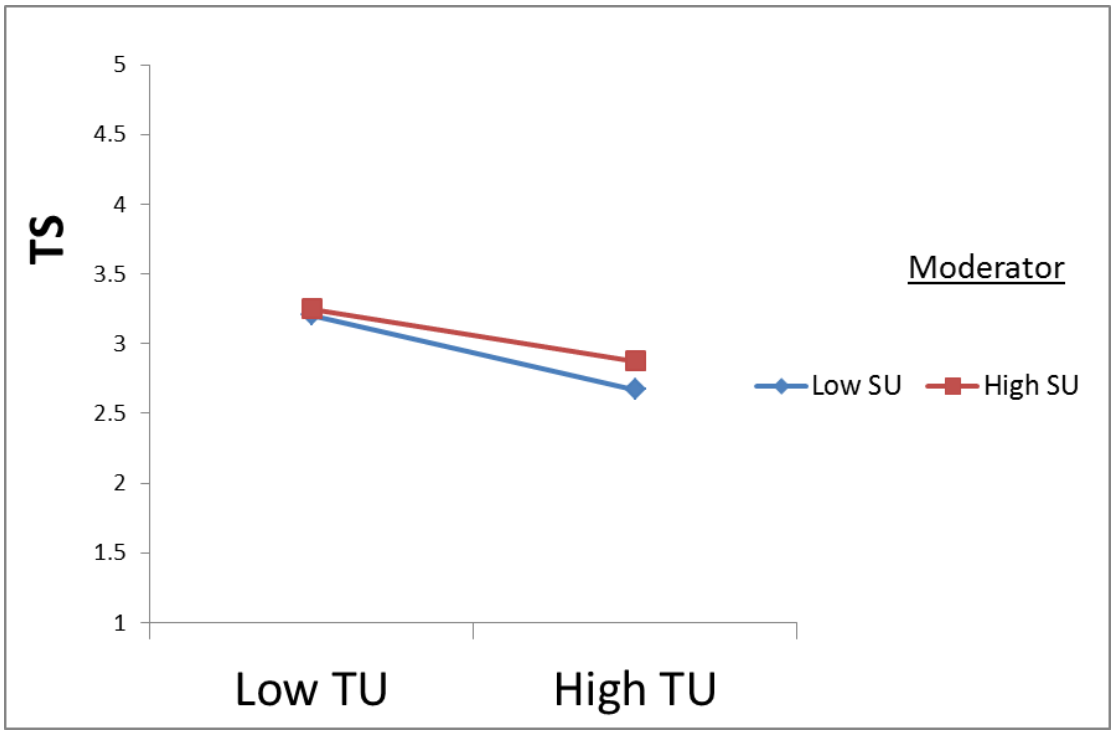
Moderating Effect: TU x SU → TK

Result: The effect of task uncertainty on task knowledge sharing is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's knowledge sharing on his or her uncertain task.



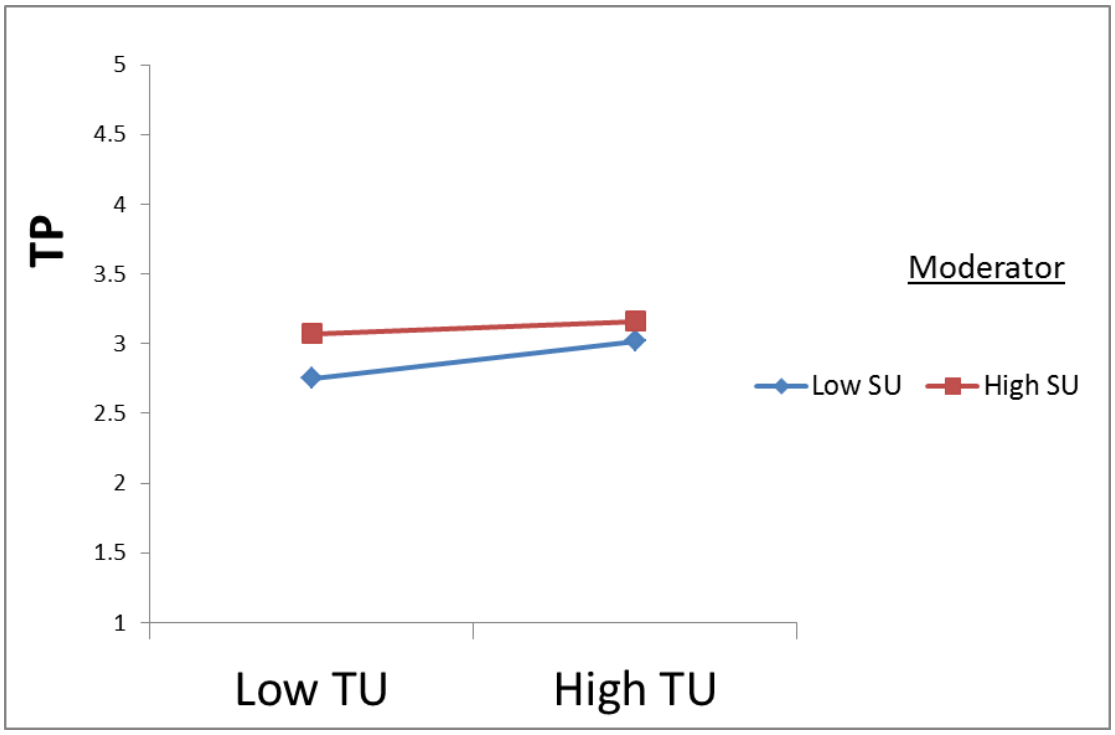
Moderating Effect: TU x SU → TS

Result: The effect of task uncertainty on task satisfaction is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's satisfaction on his or her uncertain task.



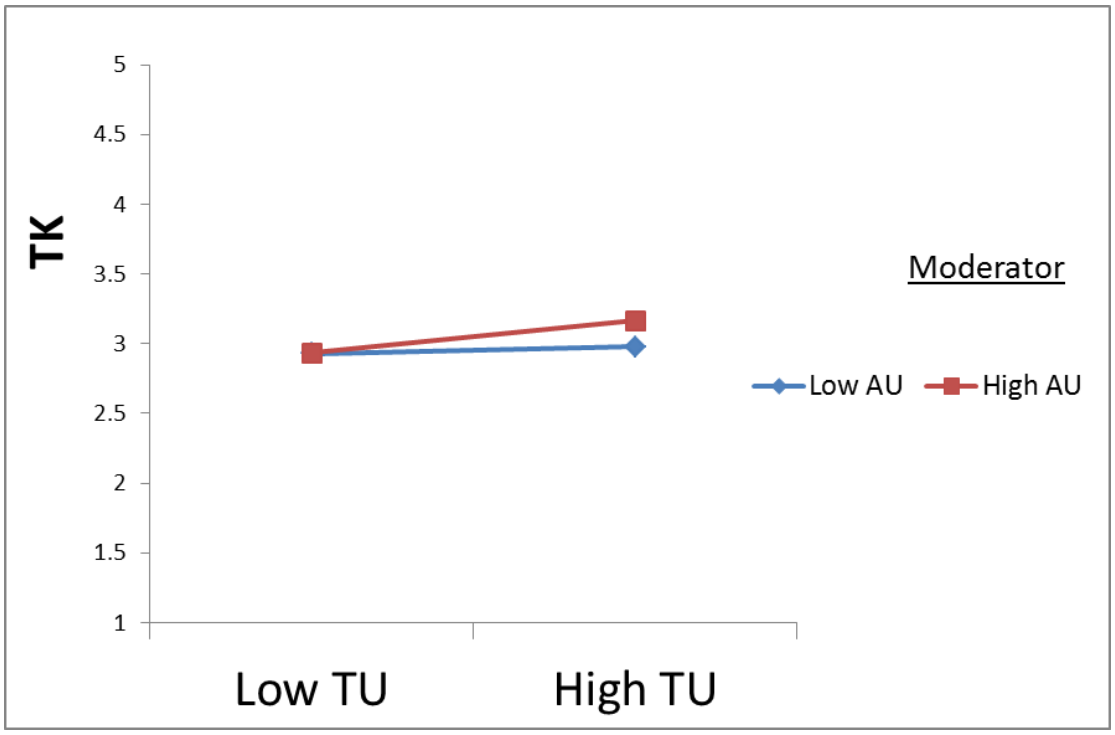
Moderating Effect: TU x SU → TP

Result: The effect of task uncertainty on task productivity is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's productivity on his or her uncertain task.



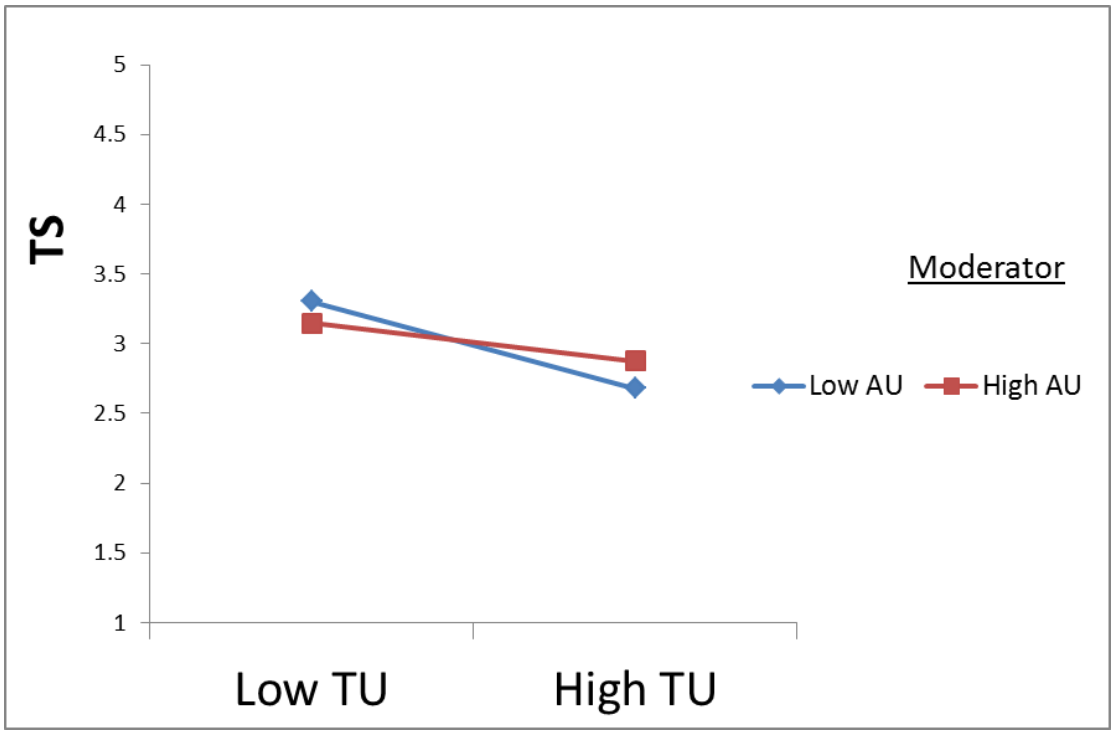
Moderating Effect: TU x AU → TK

Result: The effect of task uncertainty on task knowledge sharing is not influenced by asynchronous collaboration technology use. That means, the greater use of asynchronous collaboration technologies to work with other team members does not impact the team member's knowledge sharing on his or her uncertain task.



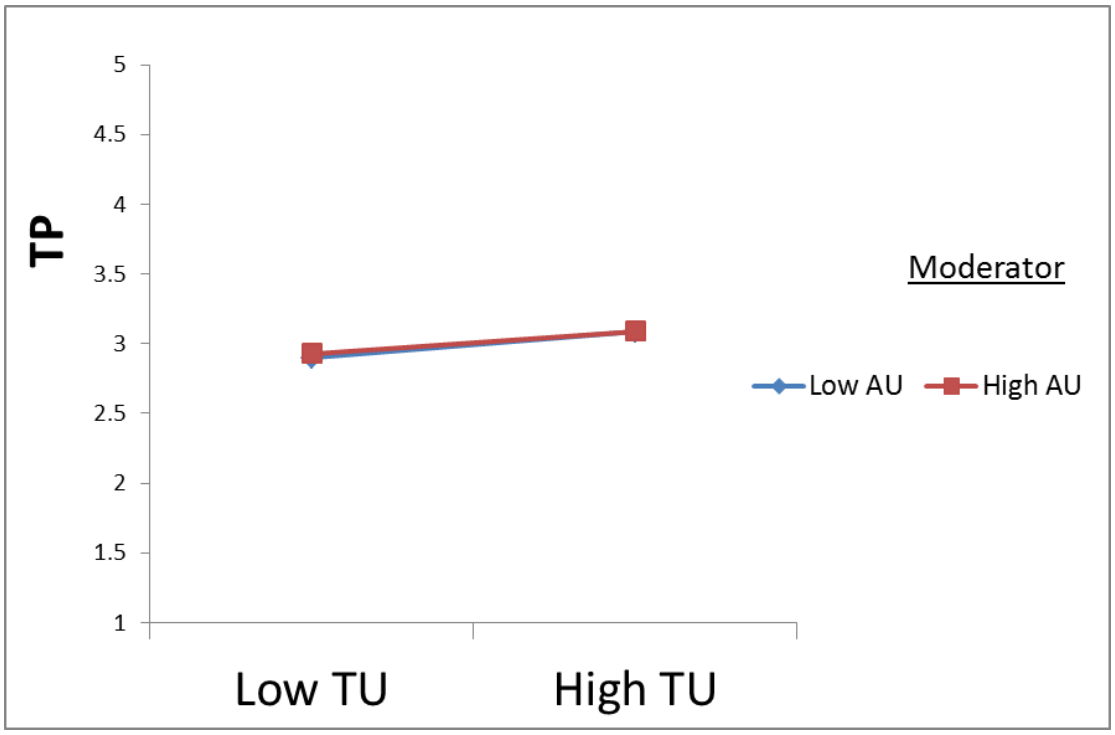
Moderating Effect: TU x AU → TS

Result: The effect of task uncertainty on task satisfaction is not influenced by asynchronous collaboration technology use. The greater use of asynchronous collaboration technologies to work with other team members does not enhance the team member's satisfaction on his or her uncertain task.



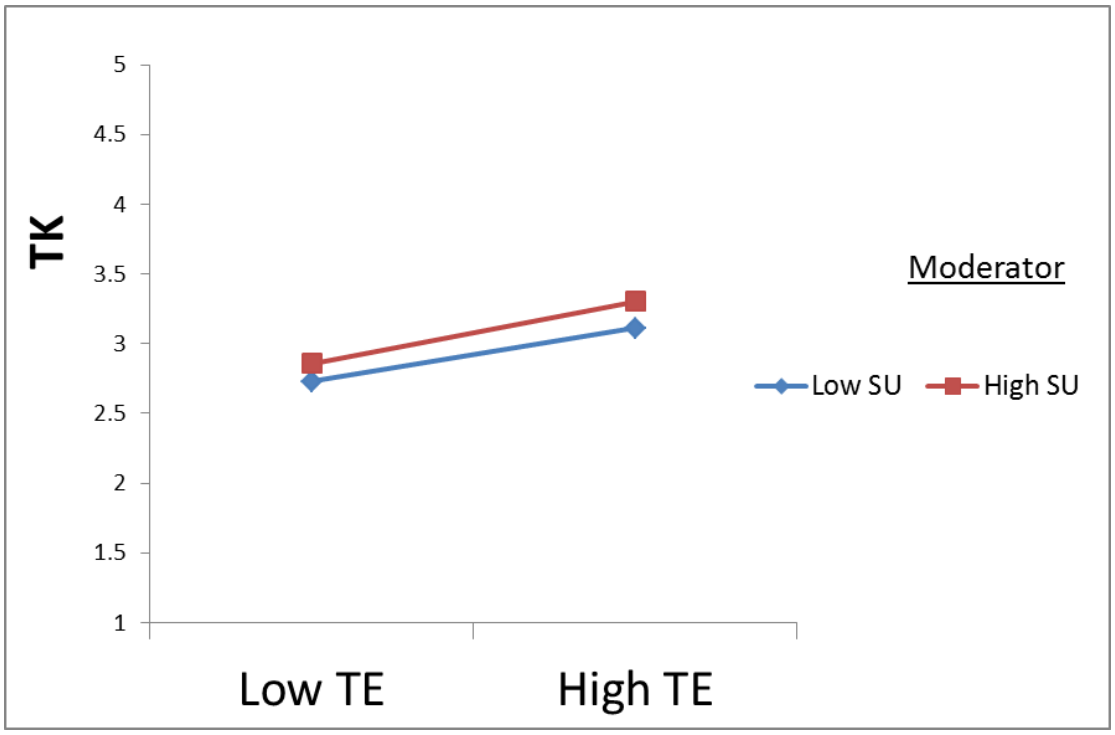
Moderating Effect: TU x AU → TP

Result: The effect of task uncertainty on task productivity is not influenced by asynchronous collaboration technology use. That means, the greater use of asynchronous collaboration technologies to work with other team members does not impact the team member's productivity on his or her uncertain task.



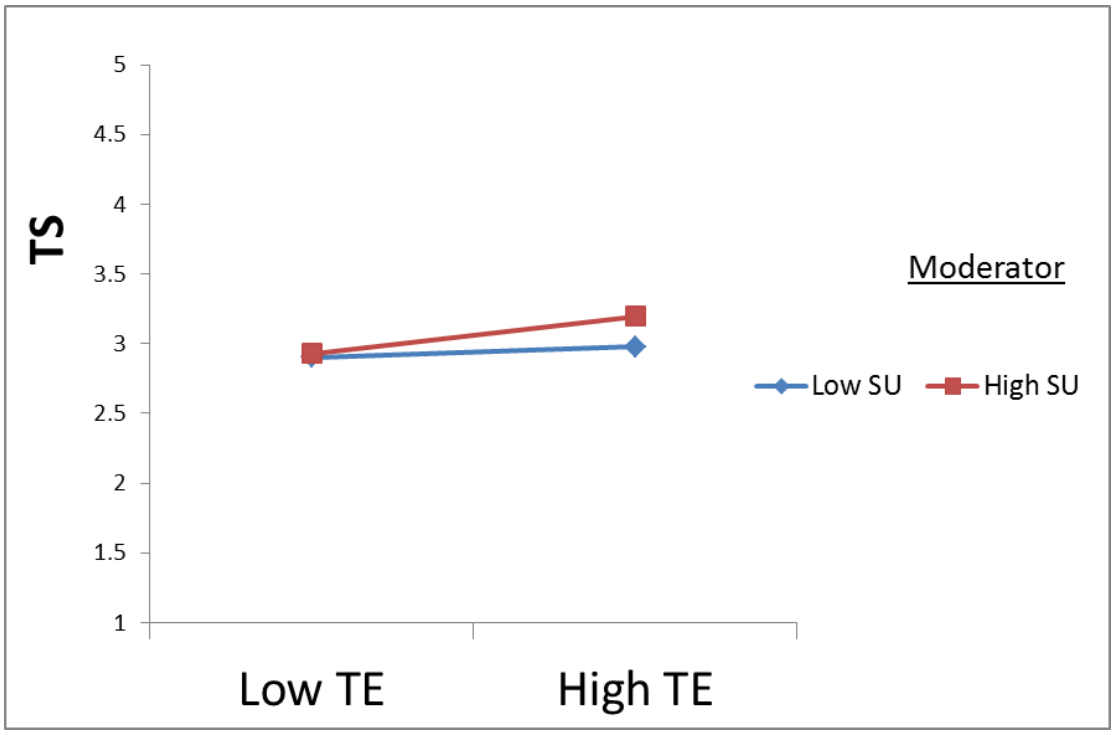
Moderating Effect: TE x SU → TK

Result: The effect of task equivocality on task knowledge sharing is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's knowledge sharing on his or her equivocal task.



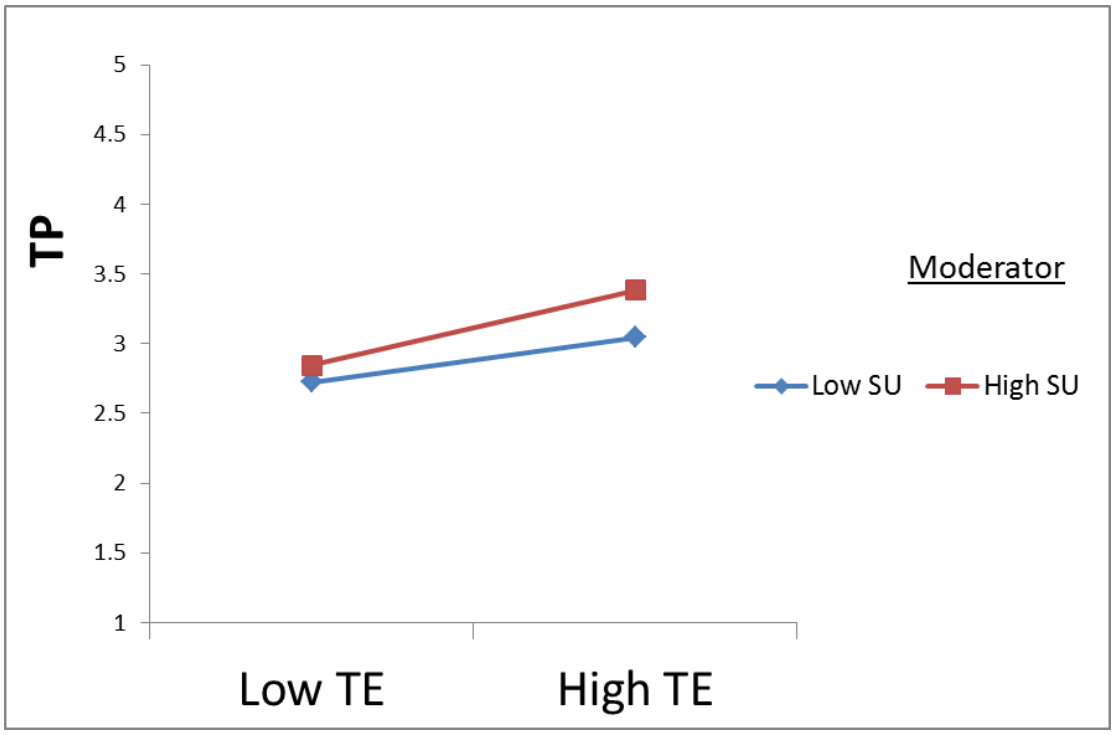
Moderating Effect: TE x SU → TS

Result: The effect of task equivocality on task satisfaction is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's satisfaction on his or her equivocal task.



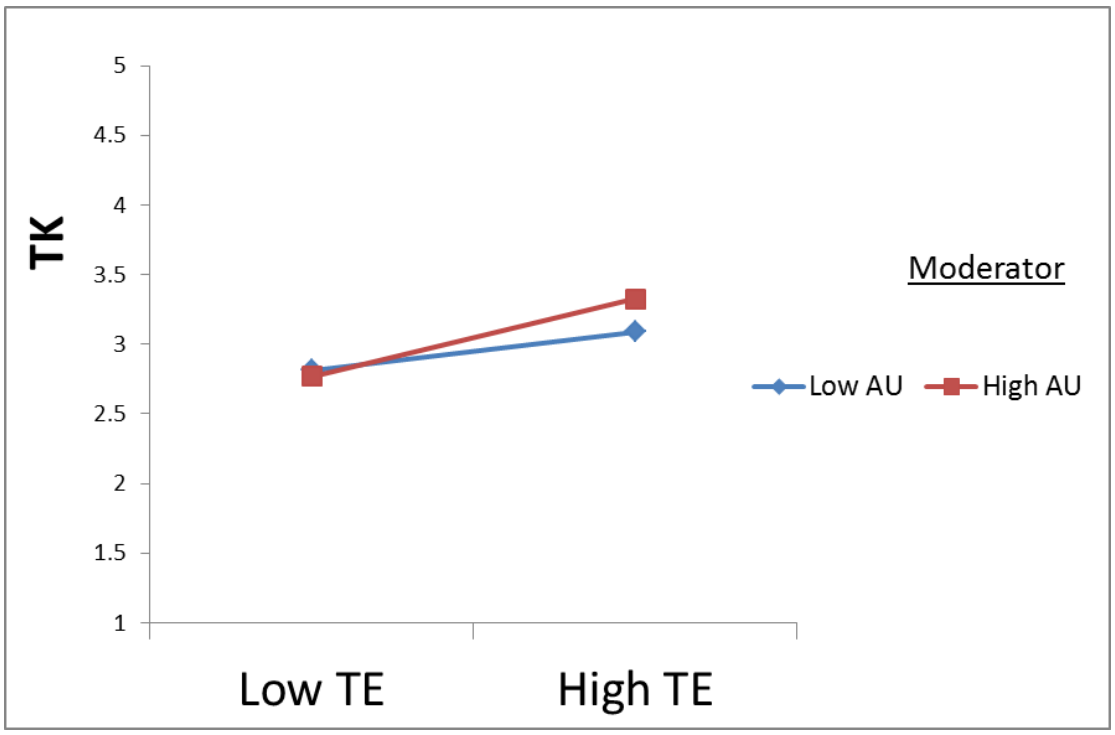
Moderating Effect: TE x SU → TP

Result: The effect of task equivocality on task productivity is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's productivity on his or her equivocal task.



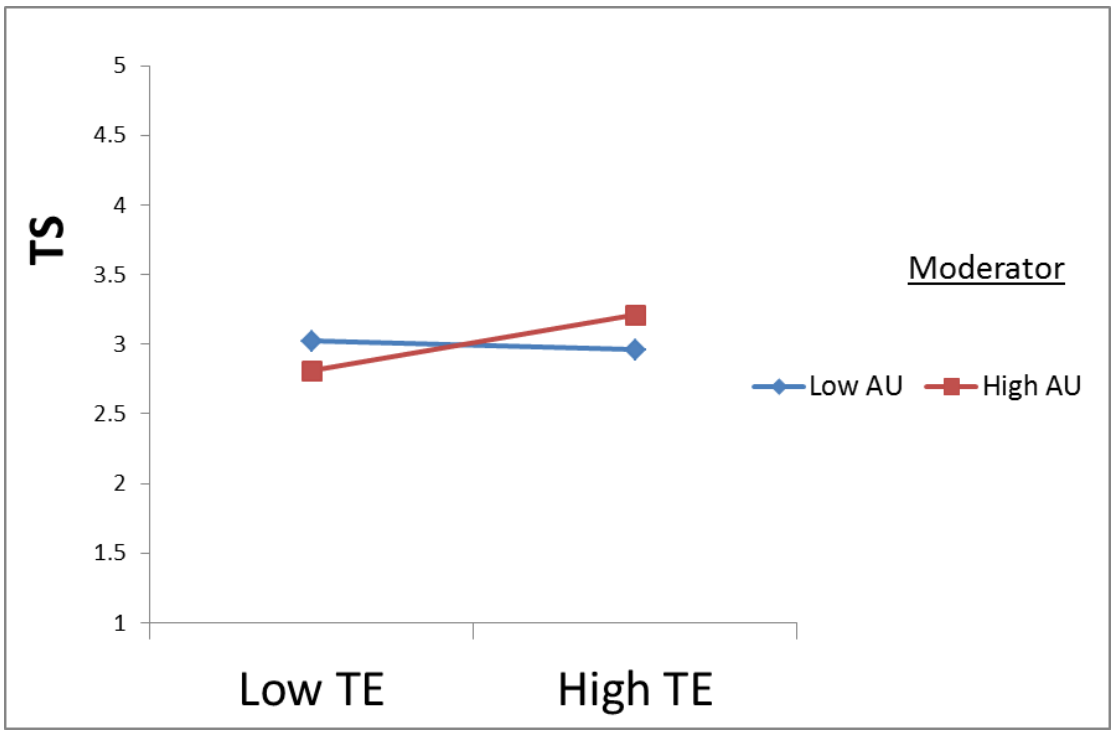
Moderating Effect: TE x AU → TK

Result: The effect of task equivocality on take knowledge sharing is influenced by asynchronous collaboration technology use such that asynchronous collaboration technology use strengthens the positive relationship between task equivocality and task knowledge sharing. That means, the greater use of asynchronous collaboration technologies to work with other team members enhances the team member's knowledge sharing on his or her equivocal task.



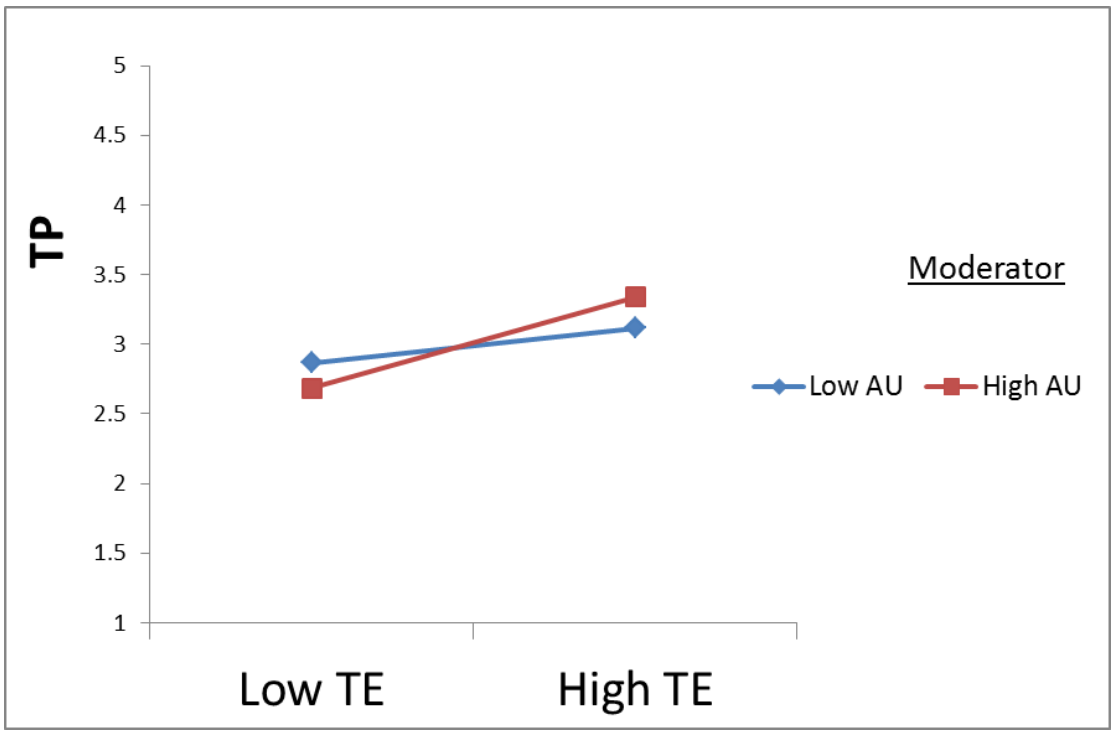
Moderating Effect: TE x AU → TS

Result: The effect of task equivocality on take satisfaction is influenced by asynchronous collaboration technology use such that asynchronous collaboration technology use strengthens the positive relationship between task equivocality and task satisfaction. That means, the greater use of asynchronous collaboration technologies to work with other team members enhances the team member's satisfaction on his or her equivocal task.



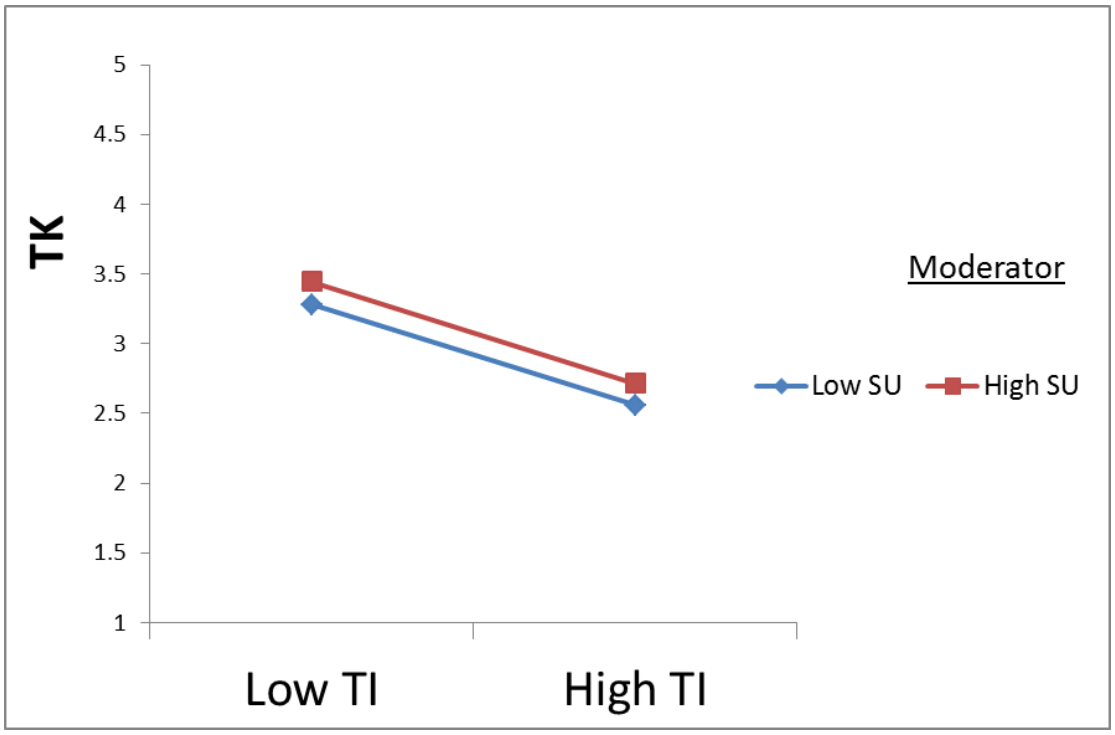
Moderating Effect: TE x AU → TP

Result: The effect of task equivocality on take productivity is influenced by asynchronous collaboration technology use such that asynchronous collaboration technology use strengthens the positive relationship between task equivocality and task productivity. That means, the greater use of asynchronous collaboration technologies to work with other team members enhances the team member's productivity on his or her equivocal task.



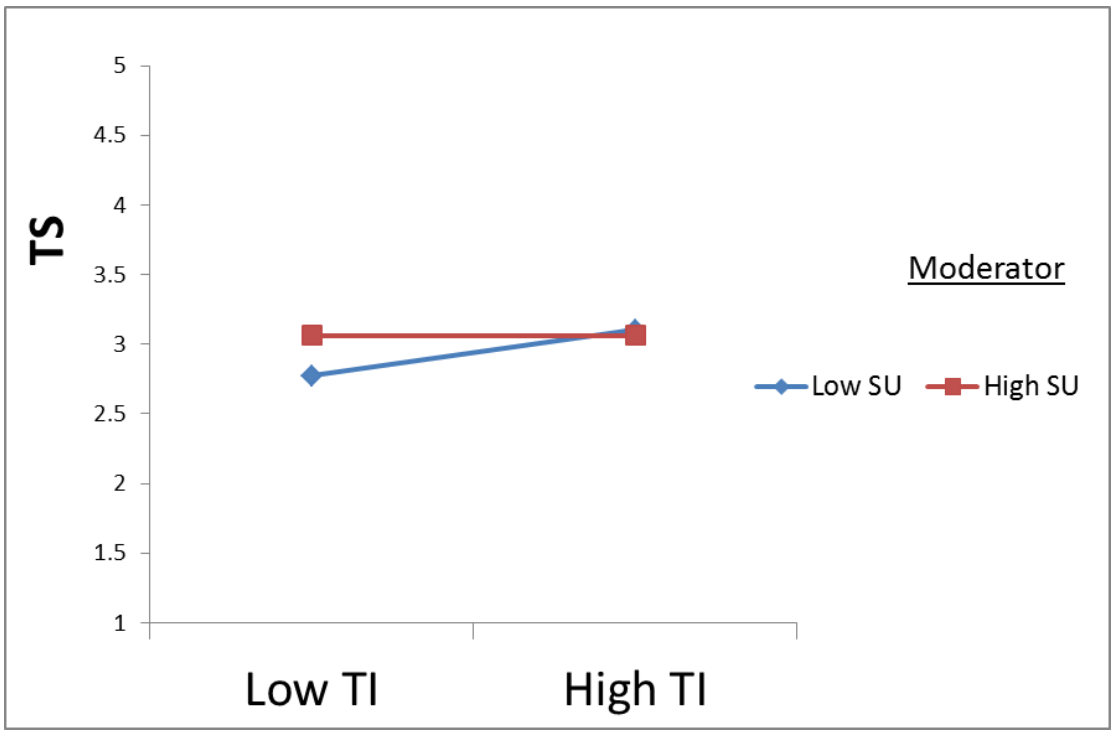
Moderating Effect: TI x SU → TK

Result: The effect of task interdependence on task knowledge sharing is not influenced by synchronous collaboration technology use. The greater use of synchronous collaboration technologies to work with other team members does not enhance the team member's knowledge sharing on his or her interdependent task.



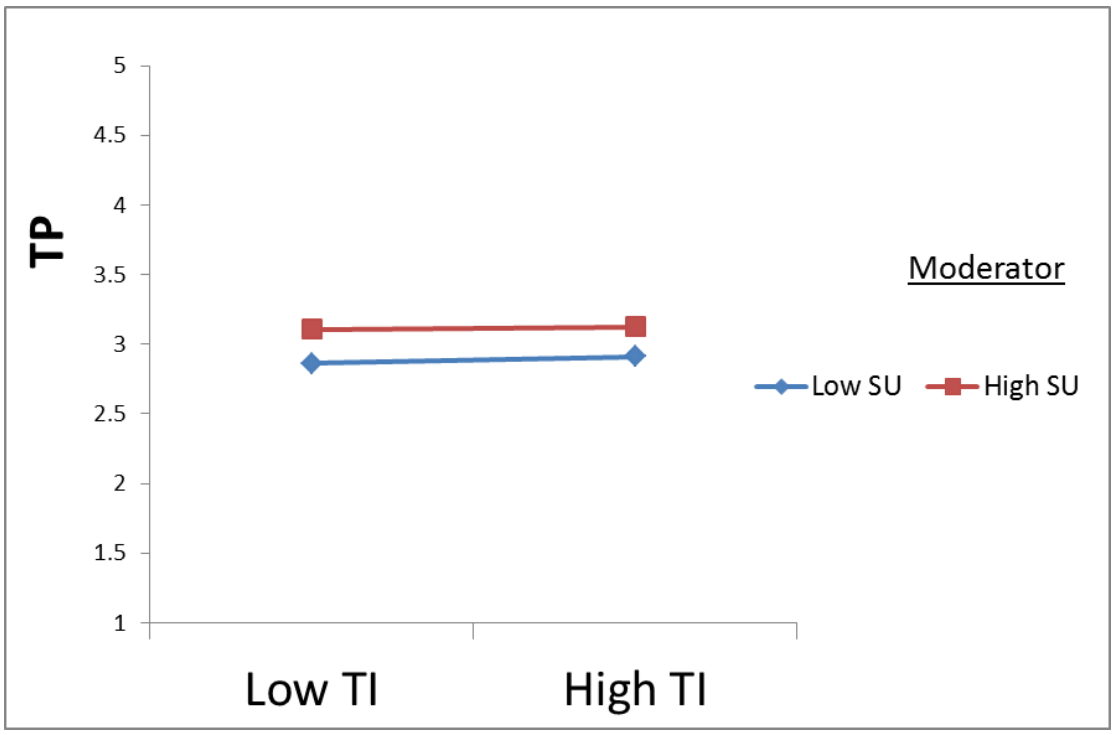
Moderating Effect: TI x SU → TS

Result: The effect of task interdependence on task satisfaction is not influenced by synchronous collaboration technology use. The greater use of synchronous collaboration technologies to work with other team members does not enhance the team member's satisfaction on his or her interdependent task.



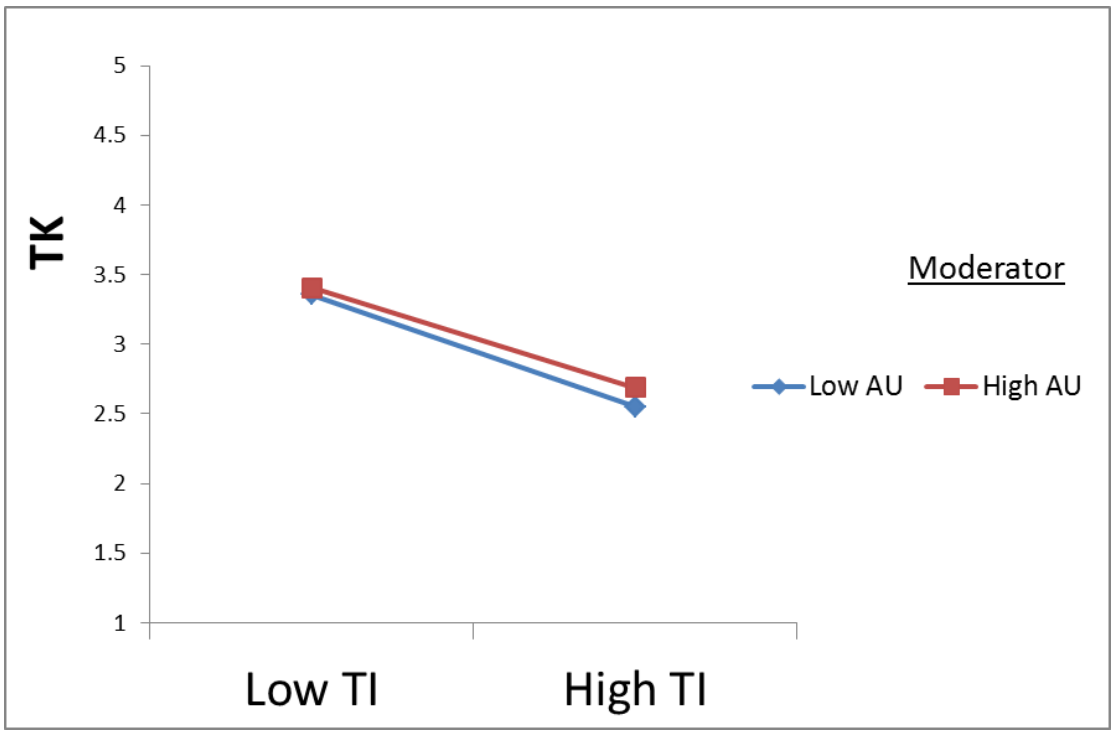
Moderating Effect: TI x SU → TP

Result: The effect of task interdependence on task productivity is not influenced by synchronous collaboration technology use. The greater use of synchronous collaboration technologies to work with other team members does not enhance the team member's productivity on his or her interdependent task.



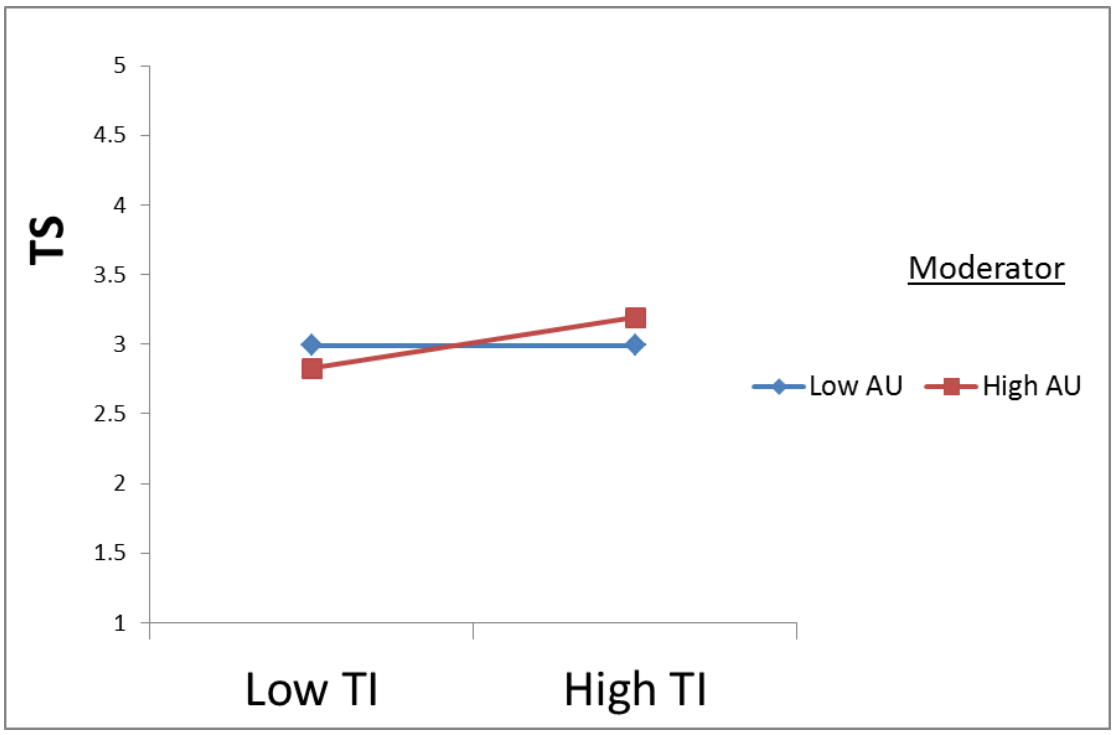
Moderating Effect: TI x AU → TK

Result: The effect of task interdependence on task knowledge sharing is not influenced by asynchronous collaboration technology use. The greater use of asynchronous collaboration technologies to work with other team members does not enhance the team member's knowledge sharing on his or her interdependent task.



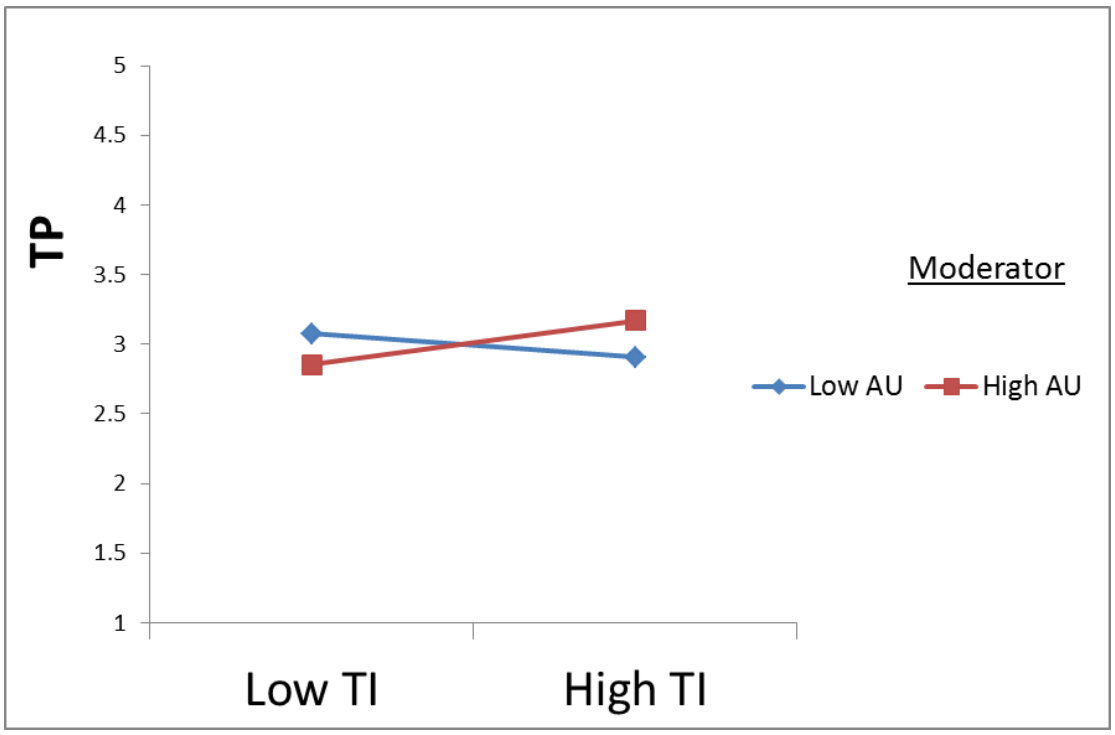
Moderating Effect: TI x AU → TS

Result: The effect of task interdependence on task satisfaction is not influenced by asynchronous collaboration technology use. The greater use of asynchronous collaboration technologies to work with other team members does not enhance the team member's satisfaction on his or her interdependent task.



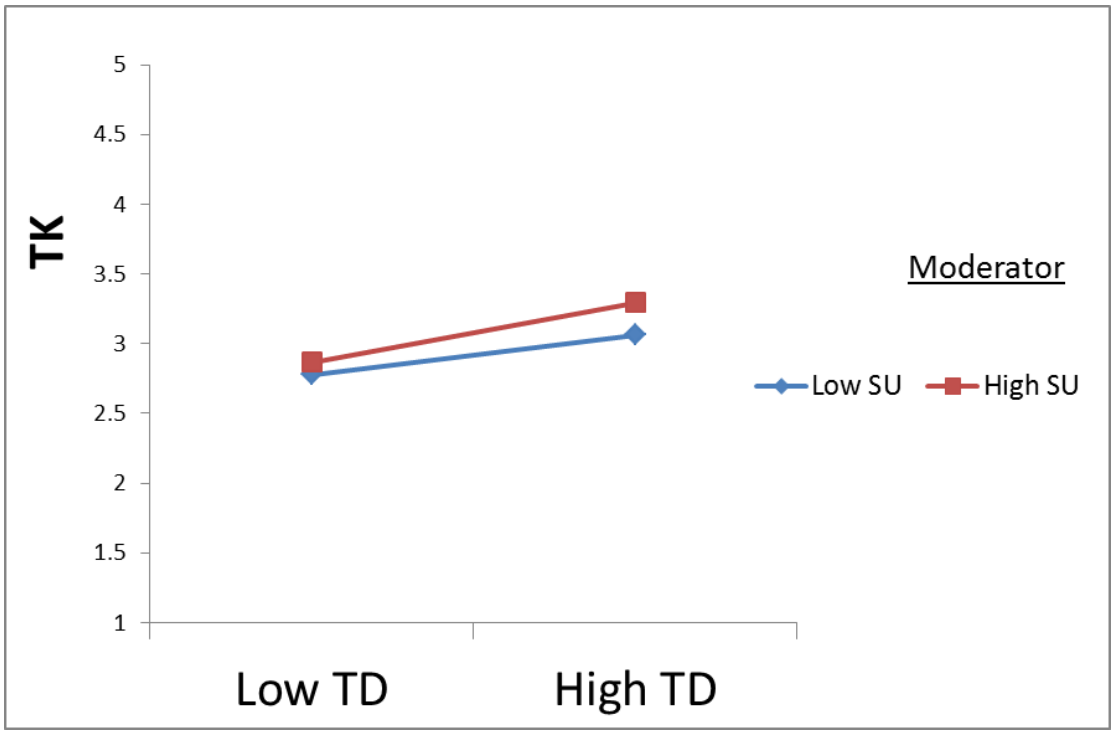
Moderating Effect: TI x AU → TP

Result: The effect of task interdependence on take productivity is influenced by asynchronous collaboration technology use such that asynchronous collaboration technology use strengthens the positive relationship between task interdependence and task productivity. That means, the greater use of asynchronous collaboration technologies to work with other team members enhances the team member's productivity on his or her interdependent task.



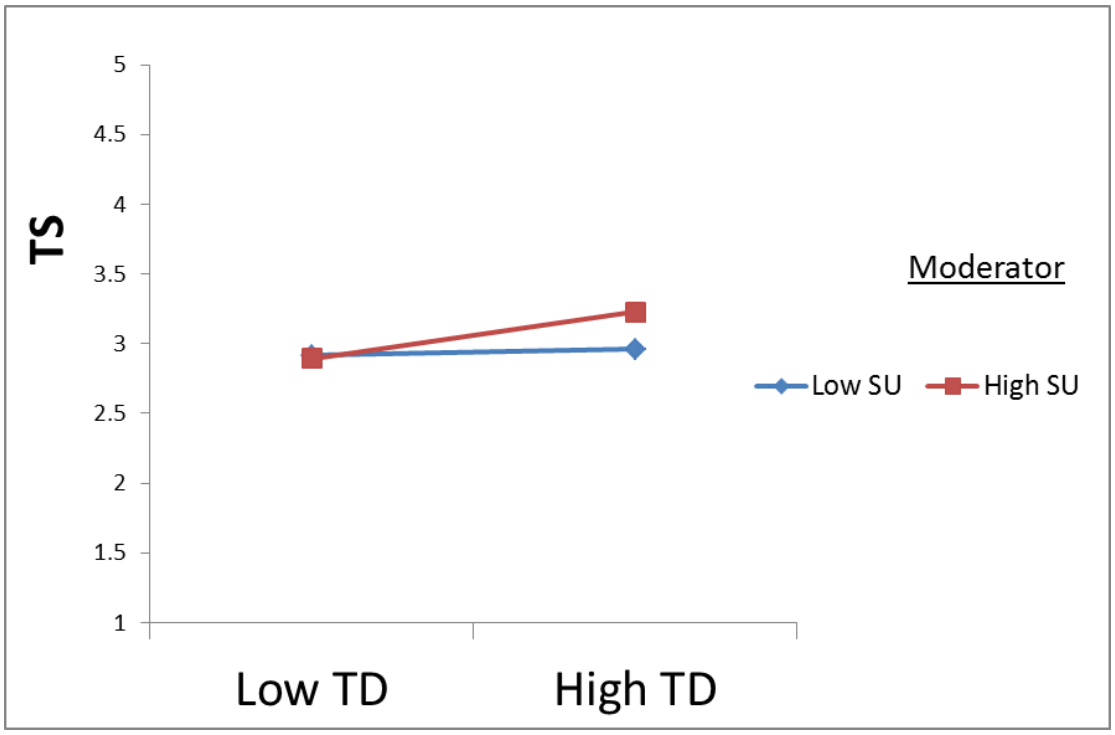
Moderating Effect: TD x SU → TK

Result: The effect of task differentiation on task knowledge sharing is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's knowledge sharing on his or her differentiated task.



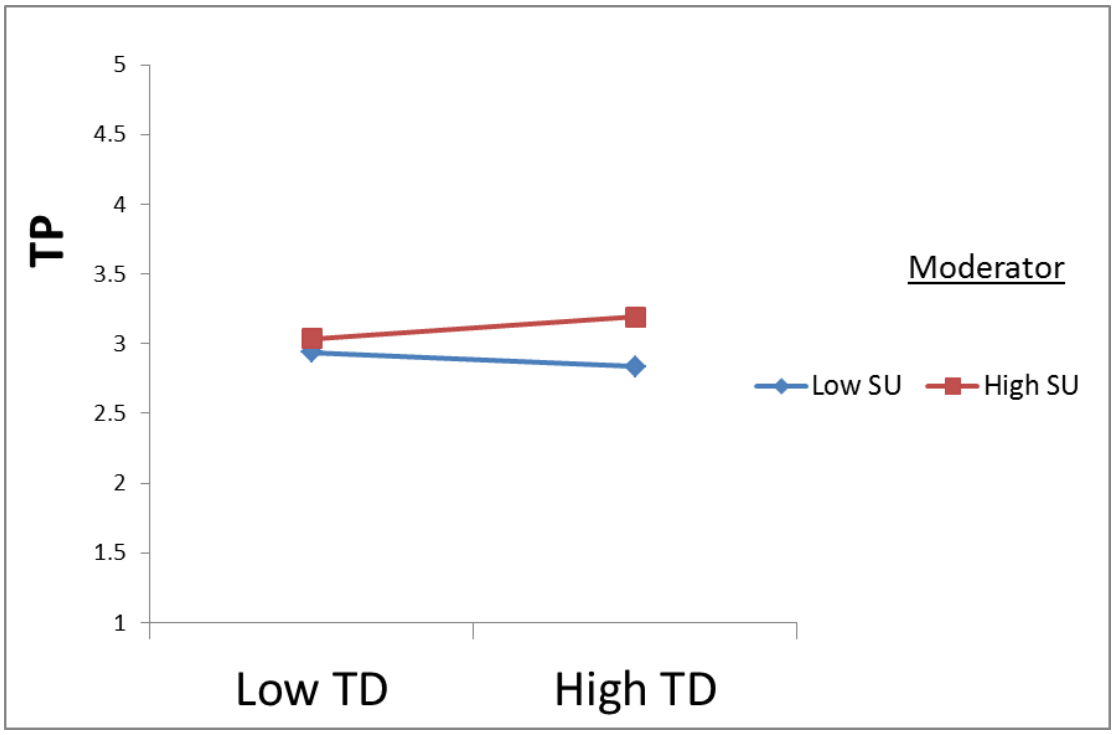
Moderating Effect: TD x SU → TS

Result: The effect of task differentiation on task satisfaction is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's satisfaction on his or her differentiated task.



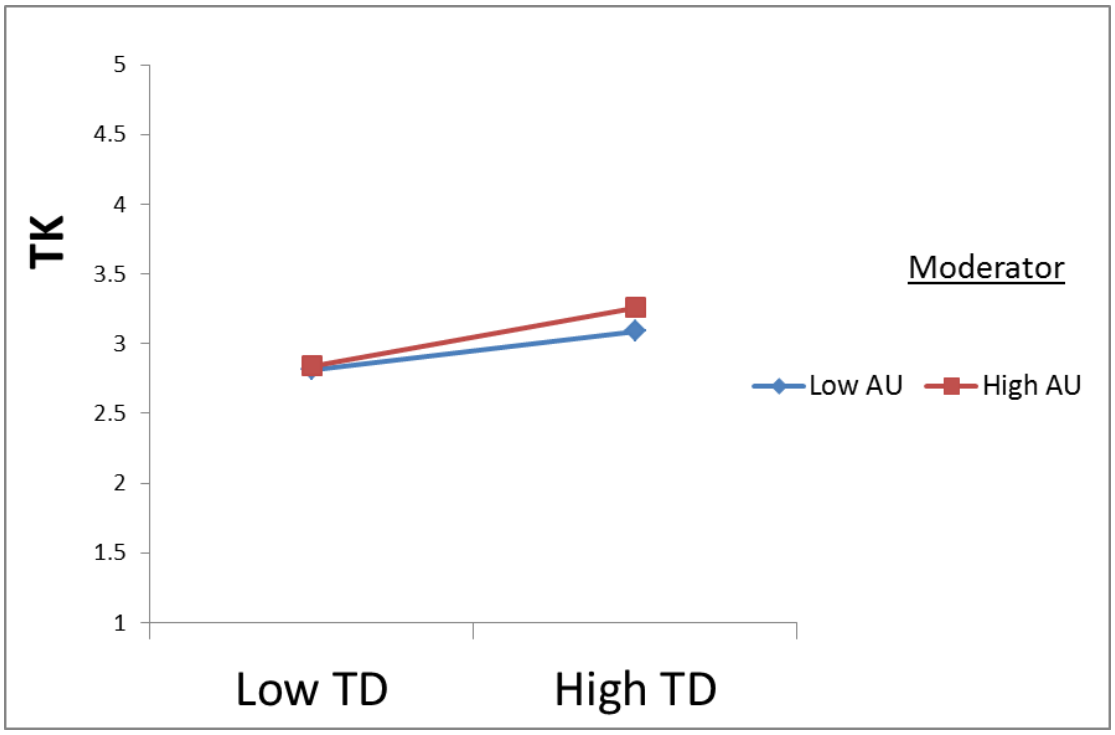
Moderating Effect: TD x SU → TP

Result: The effect of task differentiation on task productivity is not influenced by synchronous collaboration technology use. That means, the greater use of synchronous collaboration technologies to work with other team members does not impact the team member's productivity on his or her differentiated task.



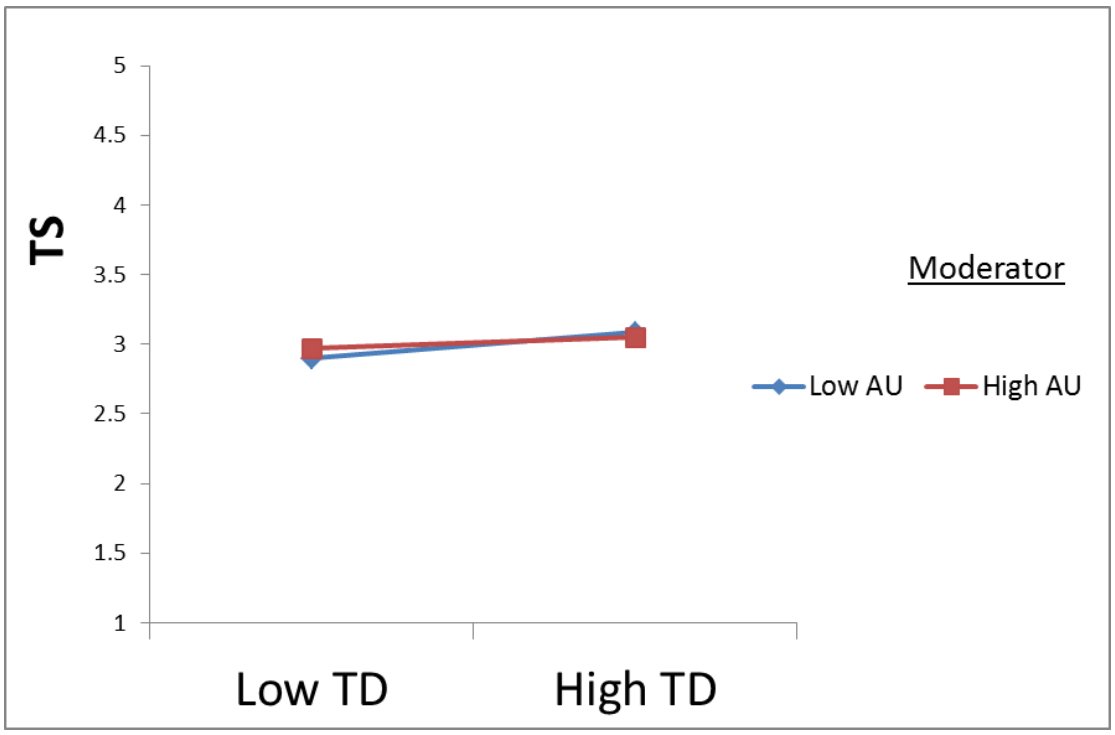
Moderating Effect: TD x AU → TK

Result: The effect of task differentiation on task knowledge sharing is not influenced by asynchronous collaboration technology use. That means, the greater use of asynchronous collaboration technologies to work with other team members does not impact the team member's knowledge sharing on his or her differentiated task.



Moderating Effect: TD x AU → TS

Result: The effect of task differentiation on task satisfaction is not influenced by asynchronous collaboration technology use. The greater use of asynchronous collaboration technologies to work with other team members does not significantly enhance the team member's satisfaction on his or her differentiated task.



Moderating Effect: TD x AU → TP

Result: The effect of task differentiation on task productivity is not influenced by asynchronous collaboration technology use. The greater use of asynchronous collaboration technologies to work with other team members does not significantly enhance the team member's productivity on his or her differentiated task.